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STAFF APPRAISAL REPORT

KOREA

SECOND POWER PROJECT

February 12, 1986

Projects Department
East Asia and Pacific Regional Office

CURRENCY EQUIVALENTS

Currency Unit - Won (W)

US$1	=	W 860
W 1000	=	US$1.16
W 1 million	=	US$1,160

FISCAL YEAR

January 1 - December 31

WEIGHTS AND MEASURES

UNITS AND EQUIVALENTS

1 meter (m)	=	3.28 feet (ft) = 100 centimeters (cm)
1 kilometer (km)	=	0.62 miles (mi)
1 kilogram (kg)	=	2.206 pounds (lb)
1 ton (metric) (t = 1,000 kg)	=	1.100 short tons (sh. tons)
1 kilowatt (kW)	=	1,000 Watts (10^3 W)
1 Megawatt (MW)	=	1,000 kW (10^3 kW)
1 Gigawatt (GW)	=	1,000 MW (10^6 kW)
1 kilowatt-hour (kWh)	=	1,000 Watt hours
1 Gigawatt-hour (GWh)	=	1,000 Megawatt-hours (10^6 kWh)
1 kilocalorie (kcal)	=	3.968 British thermal units (Btu)
1 atmosphere (atm)	=	14.70 pounds per sq inch = 1.033 kg/sq cm

ABBREVIATIONS

EHV	Extra High Voltage
EPB	Economic Planning Board
EPGCC	Electric Power Group Coordination Council
ISWACO	Industrial Sites and Water Resources Development Corporation
KAERI	Korea Advanced Energy Research Institute
KDI	Korea Development Institute
KEMCO	Korea Energy Management Corporation
KEPCO	Korea Electric Power Corporation
KEPOS	Korea Electric Power Operating Service Company, Limited
KGC	Korea Gas Corporation
KHIC	Korea Heavy Industries and Construction Company
KMPC	Korea Mining Promotion Cororation
KNFC	Korea Nuclear Fuel Company, Limited
KOPEC	Korea Power Engineering Company, Limited
LNG	Liquified Natural Gas
LRMC	Long-Run Marginal Cost

KOREA

KOREA ELECTRIC POWER CORPORATION
SECOND POWER PROJECT

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This report was prepared on the basis of an appraisal carried out in July 1985 by C. K. Chandran, C. P. Ohri, H. Razavi, J. Chang and P. C. Kapur (consultant).

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MAP

IBRD No. 19075R

KOREA

SECOND POWER PROJECT

Loan and Project Summary

Borrower: Korea Electric Power Corporation (KEPCO)

Guarantor: Government of Korea (GOK)

Loan Amount: $230 million

Terms: 15 years, including 3 years grace, at the standard variable interest rate.

Project Description: The main objective of the project is to support KEPCO's program of constructing additional transmission and distribution facilities to match its generation expansion program and meet the demand growth. It will also assist KEPCO in end-use survey and load mangement, improvement of planning techniques and rationalization of tariffs. The project consists of: (a) the transmission and distribution (T/D) component of KEPCO's 1986-1989 investment program; (b) technical assistance and engineering services; and (c) a program for strengthening KEPCO's Research Center.

Risks: The only risk of any significance is that of delay due to slow completion of the project on account of limitations on KEPCO's financial resources, but this risk is considered minimal.

Cost Estimates:

	Local	Foreign	Total
		(US$ million)	
Transmission lines	513.4	198.7	712.1
Substations	252.9	257.9	510.8
Distribution	992.8	360.1	1,352.9
Research	2.0	5.0	7.0
Engineering	0.9	0.1	1.0
Technical assitance	0.9	0.1	1.0
Total Base Cost	1,762.9	821.9	2,584.8
Physical contingencies	72.1	43.0	115.1
Price contingencies	205.4	162.7	368.1
Total Project Cost /a	2,040.4	1,027.6	3,068.0
Interest during construction /b	-	2.6	2.6
Total Financing Required	2,040.4	1,030.2	3,070.6

/a Inclusive of taxes and import duties estimated at $388.6 million.
/b Capitalized interest during construction, applicable only to project components where the construction period exceeds one year.

Financing Plan:

	Local	Foreign	Total
		(US$ million)	
IBRD	-	230.0	230.0
Internal cash generation	1,462.0	-	1,462.0
Other borrowing	578.4	800.2	1,378.6
Total	2,040.4	1,030.2	3,070.6

Estimated Disbursement:

Bank FY	1986	1987	1988	1989	1990
			(U.S. $ million)		
Annual	1.5	43.5	45.0	70.0	70.0
Cumulative	1.5	45.0	90.0	160.0	230.0

Rate of Return: 15%

Staff Appraisal Report: No. 5893-KO dated February 12, 1986

Map No. 19075R

KOREA

THE SECOND POWER PROJECT

I. THE ENERGY SECTOR

A. Overview

1.01 Korea's indigenous commercial energy resources are extremely limited, consisting of hydroelectric power (2,000 MW) and coal (635 million tons). Nevertheless, Korea's buoyant, expanding economy is highly energy-intensive - the second highest among major countries of Asia (para. 1.02). Oil accounts for over 56% of the total energy consumption, followed by coal at 33%. Korea imports all of its oil requirement and about 35% of the total coal consumption. The use of firewood - the main non-commercial fuel - which was as high as 45% of total energy consumption in 1965 has now been reduced to about 5%. Nuclear (4.5%) and hydroelectric sources (1.5%) account for the balance. Indigenous energy resources have been developed to optimum levels and all future growth will depend on import of fuels.

B. Energy Consumption

1.02 During the last two decades energy consumption in Korea grew at an average annual rate of 8%, from 11 million tons of oil equivalent (MTOE) in 1965 to about 42 MTOE in 1983. The Korean economy now is almost twice as energy intensive as other countries at a similar level of income. The principal reasons are the high share of manufacturing in the Korean economy, the rapid growth of energy-intensive industries during 1970s; and the relatively cold climate, resulting in substantial space heating requirements.

1.03 The industrial sector's share of the total consumption was about 30% in 1970, increased to 43% by 1980, and is expected to remain stable around this level until the end of the century. Energy consumption in the transportation sector was less than 10% in early 1970s, increased to 15% in 1983, and is projected to reach 22% by the end of the century. The share of residential and commercial energy consumption declined from 50% in early 1970s to 36% in 1983, in response to the rapid growth of energy prices. Further efficiency improvement measures are expected to reduce it to 24% by the end of the century.

C. Energy Strategy

1.04 During the period 1965-80 imports of petroleum fuels increased by a factor of 15 making the Korean economy highly vulnerable to price fluctuations in the international oil market. After the oil price increases of the 1970s, the economy experienced severe recessions and large balance-of-payment deficits and Korea had to borrow heavily abroad to meet increased oil import bills. The Government of Korea (GOK) then adopted a strategy of: (a) reducing the dependence on petroleum by diversifying into alternative energy

sources such as nuclear, coal and natural gas; (b) choosing a wider spectrum of energy suppliers for oil and other energy imports and participating in overseas petroleum exploration and development ventures; and (c) readjusting the industrial structure of the economy, fostering energy conservation to reduce the rate of growth of energy demand.

1.05 Korea pursued these policy changes with great vigor and speed, achieving impressive results. On the supply side, heavy investments were made in nuclear energy; this resulted in the creation of nuclear generating capacity of 2,900 MW which will increase to 7,600 MW by 1989. Korea participated in several offshore petroleum exploration ventures with Japan and private oil companies. It entered into long-term agreements with various suppliers of oil and gas, including a contract with Indonesia to import two million tons of liquified natural gas (LNG) per annum for 20 years, starting in late 1986. On the demand side, the energy-GDP elasticity was reduced from 1.1 in mid-1970s to about 0.9 in 1983-84 by increasing the efficiency of technological processes involved in the transformation, transmission and consumption of energy and slowing down the relative growth of energy intensive industries as compared with light manufacturing. As a result, the technical efficiency of energy use in Korea is high by international standards.

1.06 Recent reviews by the GOK and the Bank (para. 2.13) have indicated that there are still considerable opportunities to improve the institutional and economic efficiency of the energy sector. Unlike the manufacturing and commercial sectors of the economy, which have been increasingly exposed to market forces, the energy sector in Korea is still subject to Government interventions through public production, regulation, price control, taxation and subsidization. These have led to considerable market imperfections and institutional inefficiencies. Realizing the critical role that market forces can play in improving the efficiency of resource allocation in the energy sector, the Government has recently shifted its emphasis from diversification of energy sources (para. 1.04) to improving the economic and institutional efficiency of the sector. Reducing dependence on imported petroleum is still important, but it is not the major objective of the energy program which is being prepared as part of the Sixth Five-Year Plan to be implemented during 1987-91. The Government's present strategy is to: (a) improve the institutional efficiency of the energy sector through the implementation of recent public enterprise reforms introduced in 1984 (paras. 3.02/3.06); (b) gradually deregulate petroleum product prices and trade; (c) manage the energy demand by using more efficient pricing policies and load management techniques; (d) monitor investment planning in the energy sector to ensure that capital expenditures are based on a least-cost development approach; and (e) promote cogeneration projects in the industrial, commercial and large residential sectors.

II. THE POWER SECTOR

A. The Power Market

2.01 Electricity supply in Korea commenced as early as 1898, but it was not until the early sixties that any significant expansion took place. Total sales of electricity and per capita electricity consumption, which were 1,213 GWh and 45 kWh, respectively, in 1961, increased to 47,051 GWh and 1,160 kWh in 1984 (Annex 1). The average annual growth rate of electricity consumption during this period was 19%, among the highest in the world. Per capita electricity consumption in Korea is presently higher than all other major countries of Asia except Japan and Taiwan.

2.02 The industrial sector has been the major electricity consumer accounting for 64% of the electricity sales in 1984. Residential (19%) and commercial (17%) consumption represent the balance. The forecasts of growth in these categories until 1996 are summarized in Annex 2. Future growth in industrial energy consumption is projected at about 7% p.a. much lower than the historical rate as increased energy costs have made it uneconomic to rely on energy-intensive industries. Residential and commercial electricity demands are expected to continue their rapid growth (about 9.5% and 8.5% respectively p.a.) due to the high rate of electrification in these sectors. By the year 2000, per capita residential and commercial electricity consumption levels are expected to be comparable with those of Japan in 1980. Overall electricity sales are projected to grow at about 8% p.a. in the period 1985-1996.

B. Generation and Transmission Facilities

2.03 The Korean power subsector is dominated by a single public utility, the Korea Electric Power Corporation (KEPCO), whose installed capacity is about 16,000 MW. Over the last two decades generation became increasingly oil-based growing from 16% in 1961 to 72% in 1980. Energy diversification policies initiated during the mid-1970s (para. 1.04) have already brought about a substantial change; presently, oil based generation accounts for 41% followed by coal 23%, nuclear 18% and hydro 14%. By 1996, nuclear power will account for about 44% of power generation with coal accounting for 36% and oil 11%. Annex 1 gives details of the growth of KEPCO's installed capacity and other relevant particulars.

2.04 KEPCO's transmission and distribution (T/D) facilities are tabulated in Annex 3. In the early 1960s, a few 154 kV transmission lines connected major power plants to the main load centers while 66 kV and 22 kV transmission lines were extended radially from the 154 kV substations to small sized load centers. Distribution voltages were at 3.3 kV, 5.7 kV and 6.6 kV for medium and 100 V for low voltages. The T/D systems have since undergone a major transformation. The main changes were: (a) by the mid 1970s, an interconnected 154 kV system was developed; (b) during the second half of 1970s, a new extra high voltage (EHV) of 345 kV grid was overlaid so that inter-area power transfers are now made over an integrated 345 kV and 154 kV power grid; and (c) in the early 1970s, a new medium distribution level of 22.9 kV was

adopted replacing the 3.3/5.7/6.6 kV systems, while the low voltage level was raised from 100 V to 200 V. These changes are largely responsible for the high reliability of supply and prevailing low loss levels that characterize the system (para. 2.12).

C. Power Sector Institutions

2.05 In addition to KEPCO (para. 2.03), there are two other small entities involved in electricity generation: (a) Kyongin Energy Company, a privately-owned company with an installed capacity of 325 MW; and (b) Industrial Site and Water Development Company (ISWACO), a government agency which at present has an installed hydroelectric generating capacity of 380 MW. Their power output is sold to KEPCO.

2.06 Several government agencies participate in the energy sector and the power sector. They are listed in Annex 5. MER has the legal authority to supervise the power industry but it shares with EPB and the Ministry of Finance (MOF) the responsibility for defining investment priorities in the power subsector. The Ministry of Construction has jurisdiction over the survey, exploration, development and use of water resources and supervises the construction of multi-purpose hydro projects through ISWACO. Finally, the Ministry of Science and Technology (MOST) is responsible for the licensing, regulation and supervision of the nuclear industry, although KEPCO retains the responsibility for the design, procurement, construction, and operation of nuclear power plants. To coordinate development strategies in the power sector the Government established an Electric Power Group Coordination Council (EPGCC) in July 1984. The constitution of this council and its functions are given in Annex 5.

D. KEPCO's Development Program

2.07 KEPCO's generation expansion program for the period (1985-1996) is summarized in Table 2.1 below. Further information is given in Annex 6.

Table 2.1: SUMMARY OF KEPCO'S GENERATION EXPANSION PROGRAM (1985-96)
(Net Additions in MW)

	1985	1986	Sixth Five-Year plan (1987-91)	Seventh Five-Year plan (1992-96)
Hydro	1,015	-	567	600
Oil	-274	-1,828	-32	-1,030
LNG	-	1,850	-	-250
Coal	280	-	-200	4,875
Nuclear	950	1.900	2,850	1,800
Total	1,971	1,822	3,185	5,995

2.08 The generation expansion program described above, which will raise KEPCO's installed capacity in 1996 to 27,000 MW, is the least cost sequence of power development to meet the forecast of load growth finalized during 1985. Earlier programs prepared by KEPCO in 1984 were based on higher demand assessments and had aimed at a target installed capacity of 35,000 MW by 1996. The substantial reductions in planned additions to generating capacity, as well as the altered composition - with a greater reliance on coal-fired, rather than nuclear, generating capacity - would reduce KEPCO's investment requirements to manageable levels, and improve the overall economy of operation.

2.09 Associated with the generation expansion program described at para. 2.08 above is the following T&D expansion program:

Table 2.2 : SUMMARY OF KEPCO'S T&D EXPANSION PROGRAM (1985-1996)

	1985	1986	Sixth Development Plan (1987-1991)	Seventh Development Plan (1992-1996)
Transmission Facilities				
(ckm)	1,139	1,476	2,193	1,679
345 kV	488	956	534	745
154 kV	651	520	1,659	864
Others				70
Substation Facilities				
(MVA)	3,223	1,833	13,670	19,400
345 kV	1,833	2,33	6,667	11,500
154 kV	1,390	1,500	7,003	7,900
Others				15,000
Distribution Facilities:				
Lines (ckm)	6,614	6,588	25,753	22,760
Transformers (MVA)	745	836	4,414	7,771

2.10 KEPCO's T/D expansion program has been designed to optimally sustain the rated voltage and to reduce the frequency of failures. T/D planning is done in two steps: (a) long-term, aimed at determining the EHV system capacity requirements; and (b) short term, to cover extension and/or expansions of facilities of 154 kV and below. The main input for T/D planning is the forecast of regional demands derived from a 10-year time series of peak load, system voltages, feeder loads, etc. at all main substations.

E. Power Sector Strategy and Rationale for Bank's Participation

2.11 Bank lending to the power sector has so far been limited to one project namely a thermal power generation project at Gojeong in 1979 (Loan 1788-KO, US$115 million). The project was completed in 1984 with a delay of six months. Both 500 MW units at this power station are working satisfactorily and the operation was a success. The project was completed at a cost about 16% lower than the appraisal estimate of $657.4 million. In addition to Loan 1788-KO, the Bank has assisted the power sector indirectly through electricity development components of the Kyonju Tourism Project (Loan 953-KO, US$125 million, in 1973), rural infrastructure projects (Loans 1216-KO and 1218-KO, US$60 million, in 1976), and the Chungju multi-purpose project (Loan 1666-KO, US$125 million, in 1979).

2.12 Since its inception in 1961, KEPCO's basic objective has been to fully meet the growing demand for electric power. KEPCO has performed this function extremely well. Over the past 20 years, power generation has increased about 20-fold providing electricity to almost 100% of households and catering fully to the country's buoyant industrial sector. Thermal efficiency of KEPCO's power plants has increased from 25% in the 1960s to 37% in 1984, while T/D losses have decreased from 25% to about 7% during the same period.

2.13 Despite the outstanding level of technical competence attained by KEPCO, avenues exist for improving the economic management of the sector through flexible pricing policies, advanced end-use surveys and a load management program and evolving therefrom the optimum level of fuel, generation and distribution mix. The Bank's policy dialogue has therefore focussed essentially on improving the economic management of the power sector. The first structural adjustment loan (SAL I) set an objective of lowering the elasticity of energy consumption from prevailing 1.1 (1974-80) to 0.9; the Koreans are currently working towards lowering it further to 0.8. SAL II contained provision for undertaking a review of the tariff structure; this study was completed in March 1984.

2.14 As part of this ongoing dialogue, the Bank carried out a comprehensive energy sector review during 1984-85, so as to assist GOK in optimizing resource allocation and attenuating the possibility of over-investing in the power sector.[1/] This review, inter alia, recommended (i) a downward adjustment in load forecasts to take account of past over-estimation for the industrial sector and improvement of the forecasting methodology to avoid similar errors in future; (ii) introduction of load management techniques including the introduction of interruptible tariffs and load shedding to shift the costly summer peak to off-peak hours; (iii) improvement in the efficiency of energy use by using waste heat for space heating in the urban load centers; and (iv) resulting, inter-alia, from the above, the desirability of making qualitative changes in investment program, including postponing the commissioning of nuclear units larger than 900 MW, reducing the emphasis on

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1/ See Republic of Korea: Energy Sector Issues, No. 5307-KO, January 1985.

nuclear energy (limiting it to two 900 MW units every three years), establishing a larger number of coal-fired plants and extending the life of existing power plants from 25 to 30 years.

2.15 Most of the above recommendations relating to adjustments in the demand forecast and consequent modulations in the investment program have been accepted and implemented by the Government. Before translating others into specific actions, there is a need for KEPCO and GOK to undertake extensive work on the design of the load management program as well as assess the feasibility of district heating and other forms of co-generation. The timing is therefore appropriate to intensify and enrich our dialogue through a loan operation in the power sector. Some critical aspects, which impinge upon the sectors investment program and which will be reviewed under the project, are considered in the ensuing paragraphs (2.16-2.23).

Demand Forecasting

2.16 Due to the recent structural changes of the Korean economy, statistical correlations of historical electricity consumption do not fully reflect the future demand pattern for electricity, and thus KEPCO's present methodology of forecasting the load using econometric models does not lead to reliable projections of demand. To arrive at more accurate projections of demand and energy supply, KEPCO's Research Center will carry out on a regular basis an end-use energy study to assess the demand in each sector of the economy and combine the results of the study with those of econometric models.

Approval of Demand Forecasts

2.17 Presently, KEPCO's demand forecast, as well as its development program, are approved by Government after periodic reviews and studies by special ad-hoc task forces. These task forces do not work in continuity and the reviews/approval process by the Government are not mandated at any specified time. To improve the efficiency of the review process GOK and KEPCO would need to formalize the review and approval mechanism. During negotiations GOK and KEPCO agreed to establish by December 31, 1986 a permanent demand forecasting committee, comprising members from MOR, EPB, KEPCO, Korea Advanced Institute for Science and Technology and Korea Institute for Energy and Resources, to review and approve KEPCO's demand forecasts and to publish the approved forecasts on an annual basis. The first approved demand forecast would be published during the first half of 1987.

Load Research and Load Management

2.18 KEPCO's expansion plan is based on the assumption that the annual system load factor would stabilize at 70%. However, considering the recent trend of an emerging summer peak which is rising substantially above the winter peak, the system load factor is likely to continue to decline to around 65% by the mid-1990s unless substantial measures are taken to implement a comprehensive load management program, covering state of the art technologies and pricing policies. If the load factor declines, it would necessitate larger investments than now planned. To avoid further decline in the load factor KEPCO will undertake a comprehensive load management program and train staff to implement this program.

2.19 In the context of the proposed project, KEPCO agreed that its Research Center will: (i) with technical assistance from the Bank, design and implement a load research and load management program which would include demand management technologies, as well as a more efficient tariff policy; and (ii) embark on an appropriate staff training program.

Investment Planning

2.20 Overall planning of the power sector should allow more flexibility to deal with uncertainties prevalent in growth of demand and relative availability and cost of fuels. This is particularly important to Korea because of its almost total dependence on imported fuel to meet all its future energy demands. KEPCO has therefore decided to: (i) review its loss of load probability (LOLP) standard, in consultation with the Bank, weighing the cost of additional investments to meet peak demand against the cost of outages in various sectors of the economy; (ii) base its future plans on a range of load forecasts with built-in flexibility for changes instead of relying on a single base demand forecast as in the past; (iii) base its least cost expansion program on a discount rate which satisfies the standards (currently 13%) applied throughout the public investment program. Lastly, GOK will intensify studies of alternative higher value uses of LNG in the industrial, residential and commercial sectors in view of the higher cost of using LNG for electricity generation.

Cogeneration

2.21 District heating and industrial cogeneration offer good prospects for improving the efficiency of energy use in Korea. GOK has recently established an entity, District Heating Corporation, and is presently implementing two pilot projects of district heating and two pilot projects of industrial cogeneration. GOK has also started a pre-feasibility study to identify the potential for combined heat and power (CHP) and industrial cogeneration. Depending on the results of this study, the Government may decide to implement a comprehensive feasibility study of the technical, as well as economic and environmental impact of implementing cogeneration projects. Once a decision is taken to proceed with a feasibility study, the Bank, if requested by the Government, would assist in defining its scope.

Electricity Pricing

2.22 Electricity rates in Korea have to be approved by the Government. Changes in the rates or tariff structure are proposed by KEPCO to the Ministry of Energy and Resources (MER), which then sends it through the Economic Planning Board (EPB) to the Price Stabilization Committee (consisting of nine economic ministries and nine non-government members) for review. After the Committee's review, EPB submits the proposal to the Cabinet for approval. If approved the new tariff schedule is issued as a Presidential Decree. Though it appears cumbersome in practice the process is efficient. KEPCO's current tariff schedule is given in Annex 4.

2.23 The average price of electricity in 1984 was 67 Won/kWh. However, the rates for various customer groups varied from 33 Won/kWh in the agricul-

tural sector to 138 Won/kWh in the commercial sector. Industrial and residential sectors paid 56 and 73 Won/kWh, respectively. Large industrial customers have been subject to time-of-use rates since 1977. Rates in the peak, intermediate and off-peak periods were initially in a 5:2:1 ratio. Since 1981 KEPCO has moved these rates closer to marginal costs by reducing the above ratio to 3:1.5:1. As a result of the peak-load pricing policy, the peak demand has recently shifted to the shoulder (intermediate) hours. Therefore, the present time-of-use rates are not consistent with the structure of the system's marginal costs. In 1984 KEPCO prepared an electric power tariff study as part of the agreements under the Second Structural Adjustment Loan which concluded that: (i) peak/off-peak intervals should be redefined; and (ii) cross-subsidies among customer groups be reduced. Subsequent changes in the cost of services, particularly of fuel prices, require updating of this study. Thus, although the study was a commendable effort and its main thrust encouraging some further work is necessary to arrive at a more rational rate structure. During negotiations agreement was reached that KEPCO would complete the study carried out under the Second Structural Adjustment Loan to overcome shortcomings determined by subsequent reviews and prepare, a revised tariff schedule by December 31, 1986 for comment by the Bank and approval of GOK.

2.24 Thus, the rationale of a lending operation in the power sector rests, firstly, on the fact that investment in this sector constitutes 40% of the public investment program and the Government and KEPCO need substantial external financing to implement such a large investment plan; secondly, a few well directed changes in the investment program could significantly improve the pattern of resource allocation; thirdly, consistent with its import liberalization policy, the Government and KEPCO have decided to permit overseas competition with industries hitherto protected for procurement under the project, and finally, GOK is currently in the process of re-examining many planning and policy issues in the context of its Sixth Development Plan and Bank's input at this stage could be of significant use.

III. THE BORROWER

3.01 KEPCO, a wholly owned government corporation, with an authorized capital of 2,000 billion won (currently subscribed 1,603 billion won) will be the borrower of the proposed loan. KEPCO was incorporated on January 1, 1982, following dissolution of the Korea Electric Company Limited (KECO) which had been created in July 1961 by merging the then existing three electric supply companies.

A. Organization and Management

3.02 Prior to May 1984, KEPCO was managed by an internal board (comprising its president, an executive vice president and six vice presidents) which was responsible both for making decisions and for implementing them. Most policy decisions were, in practice, taken by the Government. After May 1984 a 2-tier management organization was introduced in KEPCO in conformity

with the recently enacted Government-Invested Enterprise Management Act,[3/]. The new organization consists of an external board of Directors responsible for policy making and an executive branch responsible for implementing the policy and for day-to-day operations.

3.03 KEPCO's new board of directors consist of a chairman, KEPCO's president and eight other members. The president of KEPCO is the only full time member of the board and all other members, including the chairman, act in a part-time capacity. The chairman and the president of KEPCO are appointed by the President of the Republic of Korea on the recommendation of the Minister of Energy and Resources. The Director General of the Electric Power Bureau of MER and the Secretary of the Committee on performance evaluation of government invested enterprises of EPB are the ex-officio members. The other members of the board are appointed by the Minister of Energy and Resources upon the recommendation of the chairman. Important functions of the board include: setting of objectives; approval of budgets, financial plans and operating programs; raising of long-term loans; acquisition of power plants of 50 MW capacity or more; and investments in other enterprises; etc.

3.04 The president is the chief executive of KEPCO and is assisted by an executive vice president and eight vice presidents each respectively responsible for: (i) planning and administration; (ii) general affairs and accounting; (iii) procurement, (iv) power generation; (v) transmission and substations; (vi) business services, including distribution; (vii) power plant construction; and (viii) research and standardization.[4/] The vice presidents of all divisions report directly to the president. Each division is subdivided into departments (presently there are 17 departments) and several offices/ bureaus. The organization is suitable for KEPCO's operations. KEPCO's organization chart is attached.

3.05 KEPCO's field offices are organized into 78 branch offices and 11 district offices. Each office is responsible for the construction, operation and maintenance of transmission and distribution lines as well as billing and collection of revenues within its jurisdiction. These offices report to a number of headquarters departments on a functional basis.

3.06 Several studies carried out in the past in Korea, including the management and organization study financed under the Bank's first power project by Coopers and Lybrand during 1980-81, pointed out that the government control over KEPCO was excessive and that KEPCO should be allowed greater autonomy for managing its affairs. The promulgation of the Government-Invested Enterprise Management Act is a positive step in that direction. The Act gives enhanced operational autonomy to KEPCO. More importantly, KEPCO's board of directors is now empowered to approve budgets which previously required MER's approval. The Act also gives greater powers to KEPCO's

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3/ The Act was made effective on March 1, 1984, and applies to 25 enterprises in which government ownership is 50% or more.

4/ Upgraded to a vice president's charge in July 1985.

president. The power to appoint the executive vice president and other vice-presidents which was previously rested in the government has now been delegated to the president of the corporation. The Act establishes a Government-invested Enterprise Management Council in the EPB for laying down basic management policy, formulating common budget guidelines and evaluating management performance of the government-invested enterprises. The Minister of Economic Planning is the chairman of the Council; the other members include the Minister of Finance, Minister of the ministry concerned with the enterprise (Minister of Energy and Resources in the case of KEPCO) and other "non-standing" members appointed by the President of the Republic of Korea. Criteria for evaluation of the management performance of KEPCO has been prescribed by the EPB. During negotiations agreement was obtained that within 2 months of their completion every year KEPCO will furnish to the Bank, for its information, copies of (a) KEPCO's report to the EPB on KEPCO's Performance and (b) results of EPB's evaluation of KEPCO's performance.

B. Manpower and Training

3.07 KEPCO is the largest government-owned corporation in Korea. Its annual investment budget is over 50% of the total budget of all the government owned enterprises. KEPCO employs about 22,000 full-time staff of whom over 50% are engineers/technicians. About 22% hold university or post-graduate degrees, 10% are technical diploma holders, 50% are high school graduates and the remaining about 18% have primary or middle level education. KEPCO's plans envisage employment of over 3,000 additional personnel over the next five years to meet its growing needs. Because of greater job security and improvement in KEPCO's salary levels as well as a drop in the private sector's demand for additional skilled manpower, KEPCO has no difficulty in recruiting and retaining qualified and experienced staff - a problem that afflicted the corporation in the 1960s and 1970s.

3.08 KEPCO has an active manpower development program incorporating local and overseas training for its management and staff. A technical high school with an enrollment of 1,800 students is operated and financed entirely by KEPCO. This provides the basic source for its recruitment. A training center established in 1961 imparts basic and advanced training courses in administration, finance, personnel and technical fields. In 1984, 7,447 employees attended these courses and the training program for 1985 covers about 8,000 employees. In addition, during 1985, 110 employees will attend training in the Research Center and in the local universities while 227 are expected to undergo specialized training or graduate school courses overseas. KEPCO has also established a cooperative program for training of its mid-level managers with the Taiwan Power Corporation.

3.09 Overall, KEPCO is an efficient and well managed utility with energetic, qualified and highly motivated staff. It annually reviews performance by standards, inter-alia, of thermal efficiency of its power stations, transmission and distribution losses, ratios of expenditures on fuel and administration in relation to sales, and financial viability. Reference to impressive improvements in thermal efficiency and T/D losses have been made at para. 2.12. During the period 1979-1984 the annual sales per employee increased 28%.

C. Accounts and Audit

3.10 KEPCO's accounting system is based on the uniform system of accounts of the US Federal Power Commission. The system is adequately designed and follows the government regulations and generally accepted accounting principles in Korea. The accounts are computerized and the financial statements are completed promptly at the end of each year.

3.11 KEPCO has a satisfactory management information system. Detailed reports comparing the actuals with the budget estimates are prepared monthly and are reviewed by the management.

3.12 A standing auditor heads KEPCO's internal audit department. He is appointed by the President of the Republic of Korea upon the recommendation of the Minister of Energy and Resources who must consult with the Minister of Finance before making the recommendation. The auditor's term of office is 2 years; he reports to KEPCO's president, attends meetings of the board of directors and submits periodic reports to the board. The internal audit department has a staff strength of about 100 of which 50% work in the field offices. The department conducts a comprehensive inspection of each office at least once in two years. The scope of the internal audit is satisfactory.

3.13 KEPCO's accounts and annual financial statements are audited by independent auditors. Till 1984 the audit was carried out by San Kyong and Company, certified public accountants affiliated with Touche Ross International. San Kyong has recently joined with Tong Yong & Co. and formed a new company called San Tong which now audits KEPCO's accounts. San Tong is affiliated with the international firm of Peat, Marwick, Mitchell & Co. The audit arrangement is acceptable. KEPCO will submit to the Bank, as in the past its annual financial statements audited by independent auditors satisfactory to the Bank together with the auditors report thereon within three months of the end of each year.

D. Billing and Collections

3.14 Billing for electricity is computerized and monthly bills are prepared for KEPCO's 6.6 million customers in 6 computer centers (Seoul, Pusan, Kwangju, Taegu, Taejon and Cheju). About 53% of the customers pay the bills through the banks. The collection ratio is good; accounts receivable are less than a month's billing.

E. Insurance, Safety Practices and Taxes

3.15 KEPCO takes out insurance policies for: (a) fire, lightning, explosion and other risks for its nuclear plants; (b) fire insurance for office buildings; and (c) automobile insurance for vehicles. The overseas materials department takes out marine cargo and erection insurance. For all other risks KEPCO maintains a self insurance scheme. Given the diversified nature of KEPCO's assets, the present insurance arrangements are considered appropriate to KEPCO's needs. In addition, KEPCO has exclusively financed the

capitalization of the Korea Electric Safety Corporation (KESCO) which has been responsible since 1974 for research and investigation of electric hazards and for providing safeguards. With a staff of over 1,000 experts and well-equipped KESCO acts as KEPCO's agent on all matters related to safety and security involving its electric power facilities.

3.16 KEPCO pays all taxes (custom duties and corporate tax, etc.) as applicable under the Korean tax laws.

F. Project Completion Report

3.17 Assurances were obtained during negotiations that KEPCO will prepare and submit to the Bank a project completion report promptly after the project is completed or within six months of the closing date of the loan, whichever is earlier. The report will cover details on the execution and operation of the project, its costs and benefits, the performance by the borrower and the Bank of their respective obligations under the Loan Agreement and accomplishment of the purposes of the Loan.

IV. THE PROJECT

A. Project Objectives

4.01 The project supports several sector objectives set out in paras 2.16-2.23. It will also assist in building up additional T/D facilities which are necessary during 1986-1989 to match the growth of KEPCO's least cost generation expansion program and meet the estimated demand growth reliably and efficiently. It will help implement important programs of end-use survey and load management, and assist in improving economic efficiency of resource utilization through improved investment planning techniques in the power subsector. Efforts at rationalizing KEPCO's tariff structure will be continued in the context of recent variations in demand characteristics and cost of services.

B. Project Description

4.02 The project comprises the following:

(a) the transmission and distribution component of KEPCO's 1986-1989 investment program;

(b) technical assistance and engineering services; and

(c) a program for strengthening KEPCO's research center.

Transmission Lines and Substations

4.03 The scope of the T/D component of the project involves (a) 1,400 circuit-kilometers (ckm) of 345 kV and 1,789 ckm of 154 kV transmission lines, (b) 6,500 MVA of 345 kV and 5,760 MVA of 154 kV substation capacity; and (c) 21,880 ckm of 22.9 kV distribution lines, 3,300 MVA of distribution transformers and other equipment.

4.04 Over the years KEPCO has steadily built up a very efficient T/D system, where voltages are maintained close to 98% of normal levels and T/D losses have been reduced from 28% (in 1961) to about 7.0% in 1984. To reduce system losses and minimize right of way problems KEPCO has followed a policy of rapidly upgrading its system voltages. Its 345 kV EHV system commenced operation in 1976 and now covers about 3,200 ckm. KEPCO's immediate objectives are to improve EHV system reliability and generally maintain its prevailing high power system standards.

4.05 The first 345 kV loop system, covering the southern area around Busan, was formed in 1982. Two more loops would be added by 1986 linking the new large nuclear and coal-fired thermal power stations in the south and west. The project will assist in completing the fourth loop in the eastern and northern areas. The EHV system is designed to deal with the imbalances of generation sources and the geographical distribution of demand. The former are located mainly in the southwest and northeast regions, for environmental and other reasons, whereas demand is concentrated in the northwest (about 40% around Seoul) and southeast (about 36% around Busan). The EHV system involves double-circuit lines and multi-conductors (4 per phase). It is designed to be able to deal with simultaneous loss of the largest generating set (950 MW) and a critical section of the transmission corridor. This is consistent with sound utility practice. KEPCO expects that in the mid-1990s a new high voltage level (possibly 800 kV) would have to be added. Studies to select the new voltage and appropriate system configuration are in progress.

4.07 During the 1986-1989 period the 154 kV system will be further expanded while 66 kV lines would be gradually eliminated. These 154 kV lines would be used as subtransmission lines for power transfer to local areas and to connect small sized new generating stations and large industrial consumers. Salient particulars of expansion of KEPCO's transmission and substation facilities during 1986-1989 are given in Annex 7 and indicated on the Map No. 19075 attached. Further details are in the project file (Annex 15).

Distribution

4.08 Initially, KEPCO utilized 3.3 kV, 5.7 kV and 6.6 kV for its primary medium distribution voltage and 100 V for the secondary low voltage supplies to households, etc. These have now largely been replaced by about 150,000 km of 22.9 kV lines forming the primary medium voltage system. Two hundred volts is the new standard low voltage. About 75% of all households have been upgraded to 200 V. These changes together with effective use of static capacitors and improvements of power factor at customer's facilities have contributed to the prevailing low loss levels (para. 2.12).

4.09 Rural electrification (RE) commenced around 1965 and is now about 99% complete. Only a few isolated islets remain to be connected to the KEPCO system. RE has modernized agriculture and the fishing industry and also reduced kerosene consumption in the country.

4.10 During 1986-1989 the project will extend the medium voltage (22.9 kV) system by about 21,880 km and add over 3,300 MVA of distribution transformer capacity for residential and commercial supplies. This will cater for annual load growth rates of 10% and conversion of the primary system. KEPCO's distribution program is definitive for the year ahead and indicative for the following years in accordance with set five year plan goals. Assurances were obtained during negotiations that KEPCO would provide the Bank, for its information and comment, annual technical progress reports on the entire T/D program pointing out any significant departures from the overall program outlined above, and setting out the basis and details of the distribution program in successive years beyond 1986.

Engineering Services and Technical Assistance

4.11 The project includes funds for (a) a standardization study for future 500 MW coal-fired thermal power stations; (b) a comprehensive load research and load management program; and (c) other energy improvement studies. The terms of reference for (a) and (b) above have been agreed with the Bank. KEPCO has agreed that those for the other studies will be submitted to the Bank before their implementation.

4.12 During 1984-85 KEPCO has been reviewing its approach to detailed engineering of some 10 large (500 MW class) coal-fired thermal power generating sets to be installed by 1996 in order to achieve the following main objectives: (a) enhancement of plant efficiency and reliability by optimizing system design parameters; (b) reducing total construction costs of future power stations by using repetitive designs; (c) better control of project construction schedules and budgets by completing more of the detailed engineering in advance; and (d) greater use of local resources for equipment manufacture and engineering. The first-phase of this study - which was carried out during September 1984-March 1985 by Korea Power Engineering Company (KOPEC) - covered conceptual design of a reference plant. It established design conditions for the mode of operation to which these generating units would be actually assigned viz. annual capacity factors of about 50% (ranging from 100% to 30% during different periods of the year). Designs involving supercritical (3,500 psig) pressures, and once-through boilers have been recommended in view of advantages of operational efficiency and flexibility and KEPCO has agreed. The purpose of the second phase of the standardization study which commenced in August 1985 is to (a) define all project systems and details which are not site specific; (b) accelerate project designs after site selection; and (c) reduce spare parts inventories by installing the same main units at all sites. The study will be completed in August 1986. The Bank has agreed with the objectives of the study and to the appointment of KOPEC. KOPEC - which is an autonomous associate of the KEPCO group and whose shares are owned by KEPCO - is a competent public enterprise specializing in engineering services. It has the necessary expertise within its own engineering organization of some 3,000 staff and collaboration agreements to

help carry out the study. KEPCO requested that Bank financial assistance for the study be included in the proposed loan and that the necessary retroactive financing of US$750,000 be provided in view of the urgency and importance of this study (para. 4.21).

4.13 The need for and objectives of the load research and load management studies have been described at paras. 2.18 and 2.19 above.

4.14 KEPCO uses technologies such as computerized load dispatching, to modernize its supply facilities. As part of the program under SAL I, KEPCO established an electric power research and development center in 1983. The center is expected to become an important tool for the planning and implementation of energy efficiency improvements such as load research and demand management. The center is also required by charter to ensure high standards of operational efficiency in the power sector by carrying out technical research on power generation and transmission equipment. KEPCO intends to build up a full-fledged research facility in the country's planned science and technology center at Taejon which will become functional around 1990-1991. On behalf of KEPCO, KOPEC is currently carrying out a detailed review of future research needs and ongoing research programs in the electricity subsector. The Bank has been requested to provide funds in the proposed loan to cover procurement of some of the equipment which would be needed for the research center during the project implementation period (1986-89). These equipment will be used: (a) to record the hourly load data for load management; (b) to analyze the system vibrations to diminish the failure of power generation facilities; (c) to conduct a full scale test of 800 kV line to choose the optimal conductor size; and (d) to examine the chemical reactions in lubricating oil, transfer oil, water treatment agents, etc.

4.15 Whereas in the past KEPCO has utilized overseas consultants for power system planning and designs, it is now well equipped to do most of the engineering work itself through KOPEC and its own in-house design depart ments. All the work of engineering and construction on the T/D component of the project will be organized in-house. The other engineering/consultancy work will be done by local consultants with limited use of expatriate specialists. These procedures are satisfactory.

4.16 The standardization study of coal-fired thermal generating units (para. 4.12) by KOPEC is estimated to require about 300 man-months and cost about $1.0 million. The average man-month cost, inclusive of travel and subsistence is about $3,300. This includes about $100,000 of direct overseas costs.

C. Cost Estimate

4.17 The total project cost over the 4-year implementation period (1986-89) is estimated at US$3,070.6 million, of which the foreign exchange component cost is about US$1,030.2 million. The costs are summarized in Table 4.1.

Table 4.1: SUMMARY PROJECT COST ESTIMATE/a

Item	Local (US$ million)	Foreign (US$ million)	Total (US$ million)	Local (Won billions)	Foreign (Won billions)	Total (Won billions)	Foreign cost as a % of the total
Transmission lines	513.4	198.7	712.1	441.5	170.9	612.4	27.9
Substations	252.9	257.9	510.8	217.5	221.8	439.3	50.5
Distribution	992.8	360.1	1,352.8	853.8	309.6	1,163.4	26.6
Research	2.0	5.0	7.0	1.7	4.3	6.0	71.4
Engineering	0.9	0.1	1.0	0.8	0.1	0.9	10.0
Technical assistance	0.9	0.1	1.0	0.8	0.1	0.9	10.0
Total Base Cost	1,762.9	821.9	2,584.8	1,515.7	706.8	2,222.9	31.9
Physical contingencies	72.1	43.0	115.1	62.0	37.0	99.0	37.3
Price contingencies	205.4	162.7	368.1	176.6	139.9	316.5	44.2
Total Project Cost	2,040.4	1,027.6	3,068.0	1,754.7	883.7	2,638.5	33.6
Interest during construction	--	2.6 /b	2.6	--	2.3	2.3	100.0
Total Financing	2,040.4	1,030.2	3,070.6	1,754.7	886.0	2,640.8	33.6

/a Includes taxes and duties in the amount of $388 million.
/b Capitlized interest during construction, applicable only to project components whose construction periods exceeds one year.

Details are in the project file (Annex 15). All costs are in 1985 prices. Physical contingencies have been provided at 5%. This is appropriate considering the nature of the project and status of implementation of the main transmission system. Price contingencies are at the rates of 5.0% in 1986 and 5.5% in 1987 to 1989 for local cost and 7.0% in 1986 and 1987, 7.5% in 1988 and 7.7% in 1989 for foreign cost and amount to 16% of the base costs inclusive of physical contingencies.

D. Financing

4.18 The financing plan for the project will be as follows:

	US$ million	% of total
Internal cash generation	1,462.0	48
IBRD loan	230.0	7
Other borrowing	1,378.6	45
Total financing requirements (including taxes and IDC)	3,070.6	100

The proposed Bank loan of US$230.0 million will meet about 9% of total project costs excluding taxes or about 7% of the gross cost of $3.07 billion. It would cover about 22% of the foreign exchange cost of the project. The proposed loan will be made to KEPCO with the guarantee of GOK and will be for a 15-year term including a grace period of 3 years. KEPCO will bear the foreign exchange risk on the Bank loan. The remaining 93% of the financing requirements for the project will be met from KEPCO's internal cash generation (48%) and foreign and local borrowings (45%). KEPCO has established a good credit reputation overseas as well as in the local market and is expected to have no difficulty in borrowing funds for the project on reasonable terms. However, during negotiations government's agreement was obtained for meeting any shortfall in funds required for completion of the project.

E. Project Implementation, Procurement and Disbursement

4.19 The project will be implemented by KEPCO during the period 1986-89 (paras. 4.25-4.27). KEPCO has ample experience in this type of work. All works are contracted out. KEPCO normally procures all goods and works for its T/D program through local competitive bidding procedures as there are now a number of suppliers within the country, ensuring a reasonable level of competition, acceptable quality and economic prices. However, during discussions with the Bank in connection with the proposed loan, in the context of recent import liberalization policies, GOK authorities and KEPCO agreed that a select list of equipment and materials required for the T/D program should be procured by KEPCO following ICB procedures in accordance with Bank Guidelines. The select list comprises transmission line towers, conductors, insulators, capacitor voltage transformers, lightning arrestors, relays, circuit-breakers and switches, watt-hour meters, and concrete poles for the distribution system. These items, except for concrete poles, are fit for ICB and foreign firms will be interested in participating, though local competition would be

strong. Qualifying domestic bidders would receive a preference in bid evaluation of 15% or the import duty, whichever is lower. The rest of the items, which are not financed by the Bank, would be procured through KEPCO's normal procedures which are satisfactory.

4.20 Except for concrete poles, all other equipment financed under the proposed Bank loan shall be procured by international competitive bidding (ICB), in accordance with the Bank's guidelines. Concrete poles, which have a 40% foreign cost component, do not lend themselves to ICB procedures because of their high freight cost. These poles will, therefore, be procured through local competitive bidding procedures which are acceptable to the Bank. Foreign firms are not precluded from participation.

4.21 KOPEC - which has just completed the conceptual study of large coal-fired thermal generating sets - will be employed for the second phase of the standardization study (paras. 4.12/4.16). The cost of the study is only $1.0 million out of the Bank loan of $250.0 million. Introducing competition for this study would delay the implementation of the study and KEPCO's generation expansion programs. KOPEC's continued employment is cost effective. The Bank therefore agreed with KEPCO's selection of KOPEC and its financing. Other consultants' services would be procured in accordance with Bank Guidelines.

4.22 Table 4.2 below summarizes the procurement arrangements:

Table 4.2: PROCUREMENT ARRANGEMENTS /a
($ millions)

	Bank		Other Procedures	
	ICB	LCB	KEPCO	Total
Transmission, distribution and research equipment	208.0	40.0	2,437.42/b	2,685.42
Engineering and technical assistance			2.0	2.0

/a For Project costs, excluding taxes.
/b Normal competitive procedures of KEPCO which are efficient and economic, and under which foreign suppliers are eligible to make bids.

4.23 All procurement documents for bidding packages for goods financed by the Bank and estimated to cost over $1,000,000 would be subject to the Bank's prior review.

4.24 The Bank loan would be disbursed on approved contracts as follows: (a) 100% of the costs of engineering consultancy services and technical

assistance; (b) 100% of the CIF price of imported equipment and materials or 100% of the ex-factory price of locally manufactured equipments and materials; and (c) 40% of the ex-factory price of concrete poles. Disbursements against consulting services and for equipment contracts costing less than US$1,000,000 million equivalent each would be made on the basis of statements of expenditure (SOEs). To facilitate disbursements a revolving fund would be established with an initial deposit of US$10.0 million equivalent to about 4 months of expected expenditures. Documents supporting the SOE's would not be submitted to the Bank but would be kept by KEPCO and made available for review by the Bank's supervision missions. Any savings under the loan would be cancelled unless otherwise agreed with the Bank.

4.25 The entire T/D program will be implemented during the period 1986-89. During appraisal, the mission reviewed KEPCO's implementation program, as also its program of procurement of equipment to meet this construction schedule (see Project File). To ensure rapid implementation, KEPCO's drafts of (a) instructions to bidders and general conditions of contract, and (b) technical specifications of transmission/substation equipments, were reviewed for inviting bids for international competition. An omnibus advertisement has been issued in the Development Forum on August 15, 1985.

4.26 KEPCO has decided that, except for transmission towers which will be procured for each line/section on multi-year contracts, all other T/D equipment will be procured on an annual basis, based on approved budgets. The following schedules have been agreed for the 1986 procurement:

(a)	Issue of bid documents	- September/October 1985
(b)	Opening of bids	- December 1985/January 1986
(c)	Evaluation of bids	- February/March 1986
(d)	Bank approval of awards	- March/April 1986
(e)	Award of contracts	- April/May 1986

The procurement for the years 1987 through 1989 will be organized on a similar basis. The main construction work will be completed by December 30, 1989, and the closing date of the proposed Bank loan will be June 30, 1990.

4.27 As most of the procurement procedures have been streamlined, construction programs have been detailed, and KEPCO has an established reputation for efficient project implementation, procurement action and construction of this project is expected to proceed smoothly. Annex 9 gives the schedule of disbursement for the project. The table also provides a comparison with the Bankwide profile for disbursements on transmission and distribution projects. The disbursement for the first two years is close to the Bank-wide profile. The faster disbursement rate during the next three years is based on the agreed implementation program and the advanced status of preparation of the project.

F. Environment

4.28 KEPCO has designed its T&D project in accordance with sound utility practice and due regard to environmental impact. This project will be no exception and will cause little disturbance to the environment. Underground

cables - though expensive - are run wherever necessary. No environmental problems are expected from this T/D project.

V. FINANCIAL ANALYSIS

A. Introduction

5.01 During the past five years, KEPCO's sales increased from 31,145 GWh in 1979 to 47,051 GWh in 1984, or at an average rate of growth of about 9% p.a. However, sales in 1984 were about 21% lower than the forecast of 59,432 GWh made at the 1979 appraisal of the Gojeong power project when sales were expected to grow at an average rate of about 14% p.a. With declines in demand growth projected to continue, KEPCO has postponed some of its major investment expenditures into the early 1990's.

B. Past Operations

5.02 KEPCO's financial operating statistics over the period 1979 through 1984 are summarized in Table 5.1. Detailed statements are given in Annex 10.

Table 5.1: SUMMARY OF KEPCO's FINANCIAL OPERATING STATISTICS

Fiscal Year Ending December 31	1979	1980	1981	1982	1983	1984
Operating revenues (billion won)	1,007	1,677	2,291	2,661	2,899	3,184
Operating expenses (billion won)	728	1,267	1,784	2,159	2,308	2,348
Operating income (billion won)	279	410	507	502	591	836
Per kWh sold						
- Average revenue (won)	32.2	51.2	64.6	69.9	67.7	67.4
- Average operating expense (won)	23.4	38.7	50.4	57.0	54.2	49.9
- Average fuel cost (won)	13.4	25.9	34.8	38.2	31.2	26.1
Rate of return (%):						
- Base I /a	10.1	8.7	8.5	7.2	7.2	9.0
- Base II /b	17.2	12.9	14.3	14.8	13.7	14.9
Debt service coverage ratio (times)	1.6	1.9	1.3	1.1	1.1	1.1
Operating ratio (%)	72.3	75.6	77.9	81.1	79.6	73.7
Current ratio (%)	88.6	82.9	72.5	58.7	48.1	41.7
Debt/equity ratio (%)	62/38	67/33	66/34	56/44	58/42	58/42
Self financing ratio (%)	17	22	9	11	6	5
Fixed Assets/Debt ratio (times)	1.6	1.3	1.4	1.7	1.6	1.7
Interest coverage ratio (times)	4.0	2.5	2.0	1.8	1.8	1.8

/a Rate base including average revalued net fixed assets in operation less consumers' contributions in aid of construction, plus works in progress and provisions for working capital.

/b Rate base including average revalued net fixed assets in operation less consumers' contributions.

5.03 Because of the large increases in fuel prices in 1980-81, KEPCO's fuel costs per kWh sold increased from 13.4 won in 1979 to 25.9 won in 1980, 34.8 won in 1981 and 38.2 won in 1982 before coming down to 31.2 won in 1983 and 26.1 won in 1984 mainly as a result of declines in international oil prices and the commissioning of some nuclear units. Fuel costs constituted over 50% of KEPCO's operating expenditures. To meet these large increases in fuel prices, the government allowed the following tariff increases: (a) February 1, 1980: 36%; (b) November 19, 1980: 17%; (c) April 21, 1981: 10%; (d) December 1, 1981: 6%. In July 1982 the Government approved a decrease of about 5% applicable to small industrial consumers followed by an average 3% decrease in April 1983 for all consumers to pass on to them the savings in fuel costs.

5.04 KEPCO's present average tariff of 67.4 won/kWh is slightly higher than its long-run marginal cost of supply. A review of the structure of the tariff will be made by KEPCO by mid-1986 (para. 2.23).

C. Financial Position

5.05 KEPCO's comparative financial position in 1984 and 1985 is given in Table 5.2. The balance sheet for 1984 is based on audited financial statements and that for 1985 is based on KEPCO's estimates.

Table 5.2: KEPCO'S COMPARATIVE BALANCE SHEETS
(Billion won)

As of December 31	1984 Actual	1985 Estimated
Net fixed assets in operation	5,785	6,927
Work in progress	3,513	3,465
Total Net Fixed Assets	9,298	10,392
Current assets	638	708
Less: Current Liabilities /a	1,531	1,576
Net Current Assets	(893)	(868)
Other assets (net)	554	720
Total	8,959	10,244
Financed by:		
Equity	3,946	4,304
Long-term debt	5,013	5,940
Total	8,959	10,244

/a Including current portion of long term debt of 1,110 and 1,167 for 1984 and 1985 respectively.

5.06 KEPCO's capital structure is sound. Inventory turnover level is also adequate. The current ratio has been maintained at less than one time including the current portion of long term debt, or about 1.7 times excluding the current portion, reflecting the high repayment requirements of its large borrowing program. KEPCO has been able to manage its liquidity position by effective working capital management and arranging refinancing when needed (para. 5.12).

D. Investment in Subsidiaries

5.07 As of the end of 1984, KEPCO has invested 148 billion won in its subsidiaries of which a major part (138 billion won) is in Korea Heavy Industries and Construction Co. Limited (KHIC). With this investment KEPCO owns 34.7% of KHIC's shares; the balance is owned by Korea Development Bank (KDB) and Korea Exchange Bank (KEB). KHIC (formerly Hyundai International, Inc.) is a manufacturer of plant and equipment primarily for power generation, steel, and petrochemical industries. It has been in financial difficulties and has been incurring operating losses mainly due to over-capacity in the sector and slower than expected growth in overseas demand. The company's net-worth as of December 31, 1984 was only about 65% of its share capital. Thus, KEPCO's share-holding in KHIC is worth about 90 billion won only, a loss of 48 billion won for KEPCO (or about 1.2% of KEPCO's equity at end of 1984), which KEPCO has not yet written off in its books. KEPCO proposes to make provision for the amortization of this loss over a number of years.

5.08 In 1983 the Government directed KEPCO to invest a further sum of 30 billion won in KHIC to provide funds for its research and development program. A sum of 7 billion won was contributed by KEPCO in 1984, 10 billion won for 1985 and the balance of 13 billion won would be invested in 1986. No further investments are planned. The Project Completion Report (Loan 1466-KO) notes that KHIC's management expects the company to return to profitability by 1986.

5.09 KEPCO's investments in other subsidiaries aggregate to a total of 10 billion won. These are in Korea Electric Power Operating Services (KEPOS) - 3.0 billion won (100% of shares); Korea Power Engineering Co. (KOPEC) - 3.2 billion won (98% of shares); and Korea Gas Co. (KGC) - 3.8 billion won (17% of shares). The value of these investments is about 12 billion won. No further investments are planned in these subsidiaries.

E. Capital Expenditures

5.10 KEPCO's investments increased from 1,999 billion won for the period 1975-79 to 7,305 billion won for the period 1980-84. A summary breakdown of KEPCO's investment is given in Table 5.3.

Table 5.3: BREAKDOWN OF KEPCO'S CAPITAL EXPENDITURES
(1975-1984 - Billion Won)

Investment program for the period	1975-79	1980-84
Capital Expenditures		
Generation	1,276	5,635
(of which nuclear)	(556)	(3,868)
Transmission	399	640
Distribution	291	910
Other	33	120
Total	1,999	7,305

5.11 KEPCO's investment programs have placed high emphasis on nuclear power generation in order to diversify its energy sources. Nuclear generation is projected to increase from presently around 25% of total generation to over 50% by 1991. The construction period for nuclear plants is longer than that for conventional plants (7 years for nuclear as compared to 4 years for thermal and 5 years for hydro plants). Since full utilization of generation capacity after the commissioning of a nuclear plant usually takes two to three more years as a learning period for safety reasons, this emphasis on nuclear investment has important financial implications. At a time when internal cash generation is restrained by slowdown in its electricity sales due to less bouyant demand in the industrial and export markets, KEPCO has to rely heavily on external borrowings to support its investment program.

5.12 The large debt service obligations associated with the borrowings have imposed a heavy burden on KEPCO. The terms (and grace periods) of some of KEPCO's borrowings have not matched the construction period and the lifetime earning power of the assets they financed as well as would be desirable. However, as a practical matter, the repayment obligations on debts with relatively short- or medium-terms have, where necessary, been met by refinancing (paras. 5.06 and 5.20). KEPCO has maintained conservative debt/equity and net fixed assets/debt ratios and has had satisfactory interest coverages. Hence, it has had a reasonable basis for arranging refinancing or new borrowings for a large portion of its construction requirements and does not expect to have difficulties in making similar arrangements in the future, when needed.

F. Financial Covenants Under Gojeong Power Project

5.13 Under the Gojeong power project (Loan 1788-KO) two financial performance covenants were agreed: (a) a rate of return of at least 9% on a rate base including (i) average revalued net fixed assets in operation less consumers' contributions in aid of construction, (ii) 100% of works in progress and (iii) provision for working capital; and (b) a minimum debt service coverage of 1.2 times. KEPCO achieved about 9% rate of return in

1980, 1981 and 1984 but in 1982 and 1983 its rate of return was 7.2% mainly due to (i) a 50% increase in the value of works in progress, (ii) lower sales growth and (iii) higher fuel costs. On a rate base consisting only of average revalued net fixed assets in operation, however, KEPCO's rate of return in each of these two years was about 14%. KEPCO follows an accelerated depreciation policy based on an average plant life of 18 years. This policy tends to understate the annual rate of return performance by about 1-2%, compared to the common practice of an average life of 25-30 years. KEPCO's practice is considered an appropriate strategy considering its large requirements of capital and was accepted under Loan 1788-KO.

5.14 With regard to the debt service coverage, KEPCO exceeded the agreed minimum in 1980 and 1981 but fell slightly below that level to 1.1 times in 1982-84 because of higher debt service obligations on borrowing for nuclear plants which are not yet in full commercial operation (para. 5.11). The Bank agreed to the lower targets for both covenants for these years in consideration of the above-mentioned reasons.

G. Future Performance

5.15 KEPCO's financial forecasts (income statements, sources and applications of funds statements and balance sheets) for the period 1986-1991 and its latest estimates for 1985 are given in Annex 11. Notes and assumptions used in the forecast are given in Annex 12. The results are summarized in Table 5.4.

Table 5.4: KEPCO'S FINANCIAL FORECASTS

	1985 Estimated	1986	1987	1988 Projected	1989	1990	1991
Sales (GWh)	50,580	54,626	59,160	64,130	69,452	75,356	81,610
Average revenue per kWh (Won)	67.42	68.18	71.93	75.89	80.06	80.06	80.06
Operating revenues (Billion Won)	3,413	3,727	4,259	4,872	5,565	6,039	6,540
Operating expenses (Billion Won)	2,610	2,919	3,431	3,830	4,287	4,692	5,138
Operating income (Billion Won)	803	808	828	1,042	1,278	1,347	1,402
Rate of return - Base I (%) /a	8	7	7	8	9	9	9
- Base II /b	13	10	9	9	10	10	11
Operating ratio (%)	76	78	81	79	77	78	79
Current ratio (%) /c	45	45	43	51	60	71	95
Debt/Equity ratio (%) /d	60/40	57/43	52/48	47/53	39/61	34/66	32/68
Net fixed assets/debt (times) /e	1.6	1.7	1.9	2.1	2.5	2.9	2.9
Self-financing ratio (%) /f	-0.3	-0.2	-1.0	0.0	41.1	51.0	50.1
Debt service coverage ratio (times)	1.0	1.0	1.0	1.0	1.3	1.5	1.8
Interest coverage ratio (times)	1.5	1.3	1.1	1.4	2.1	2.4	2.8

/a On average revalued net fixed assets in operation less consumers' contributions, plus works in progress and provision for working capital.
/b On average revalued net fixed assets less consumers' contributions.
/c Current assets as percentage of current liabilities.
/d Including other liabilities (such as provisions for self-insurance severance pay, assets retirement) as part of debt.
/e Total net fixed assets divided by long-term debt and other liabilities.
/f After deducting increases in working capital (less cash).

5.16 KEPCO's financial forecasts have been analyzed applying, inter alia, three standard criteria: (a) satisfactory financial performance as measured by a rate of return on revalued net fixed assets in operation; (b) internal cash generation sufficient to meet a reasonable proportion of KEPCO's investment program; and (c) acceptable capital structure and debt service coverage. These are discussed in paras. 5.17 - 5.21 below.

H. Rate of Return

5.17 Based on the usual criterion of the rate of return (ROR) on revalued net fixed assets in operation (less consumers' contributions), and assuming tariff increases in 1986-89 to offset inflation and maintaining them at the 1989 current level in 1990 and 1991, KEPCO will achieve a ROR of about 10% in 1986 and range between 9% and 11% in 1987 through 1991. Though lower than the 13% - 15% rate of return achieved in 1980-84, this level of performance is fully acceptable given the slowdown in demand growth, high costs of LNG fuel,

large increases in the asset base, and the time lag between commissioning and full commercial utilization of nuclear energy.

5.18 Using the higher rate base (i.e. including 100% of works in progress and provision for working capital) for calculating the rate of return, KEPCO will achieve about 7-8% in 1986-88 and about 9% in 1989-91. While including works in progress in the rate base may have been deemed appropriate in 1979 for the Gojeong power project, that approach has been reconsidered for the following three reasons:

(a) Comparing the slower, albeit still very substantial, rates of growth in electricity sales against what were expected in 1979, it appears in retrospect that the financial targets established at that time were over-ambitious;

(b) The general practice followed by most utilities and in other Bank-financed projects is to exclude works in progress from the rate base. The usual practice in Bank-financed projects is to wait until new plant is commissioned and earning revenues before beginning to recover the costs from consumers; and

(c) KEPCO's works in progress are uneven. They are projected to decrease from the present level of 55% of average net fixed assets to 17% in 1988, 9% in 1989-90, 17% in 1991 and rise again to about 56% in 1994. Their inclusion in the rate base would, therefore, tend to distort the picture of KEPCO's financial performance as measured by the rate of return on assets in operation.

5.19 The commonly used definition of rate base (i.e. average revalued net fixed assets in operation less consumers' contributions) will be adopted for measuring KEPCO's financial performance under the proposed loan. The minimum rate of return requirement will be 9% for the period 1986-1988, and 10% from 1989 onwards. Assuming increases in electricity rates in 1987 to 1989 to offset inflation at the same levels and to reflect the long run marginal cost, KEPCO's projection shows that it will be able to meet these minimum rate of return requirements and improve its self-financing ratio to a satisfactory level with adequate internal cash after meeting its debt service obligations (paras. 5.20 and 5.21).

I. Capital Structure and Debt Service Coverage

5.20 KEPCO's capital structure is sound. No further GOK equity investment in KEPCO is planned. Debt as a percentage of total capitalization is projected to decrease from 60% in 1986 to 47% in 1988 and further to about 32% in 1991. KEPCO's debt service obligations have been on the rise and that trend will continue through 1988. Its debt service of 728 billion won in 1982 (excluding interest charged to construction) nearly doubled to 1,450 billion won in 1985 and will triple to 2,299 billion won in 1988 before it comes down to 1,992 billion won in 1990 and to 1,838 billion won in 1991. This high level of debt service obligations arises from borrowings with terms which poorly matched the construction period and lives of assets they financed

particularly for the nuclear generating plants. However, KEPCO will have no difficulty in continuing to maintain its satisfactory asset to debt ratio and interest coverage ratio (para. 5.12); the net fixed asset to debt ratio is estimated at above 1.6 times in 1985 and will continue to rise to about 2.9 times from 1990 onwards and the interest coverage ratio will remain above 1.1 times and increase to about 2.8 times by 1991. KEPCO's debt service coverage ratio (DSCR) is estimated to be about 1.0 times in 1986-1988 and will improve to 1.3 times in 1989 and 1.8 times in 1991. This growth of debt service coverage is satisfactory.

J. Self-Financing Ratio

5.21 For reasons explained in paras. 5.11 and 5.20, KEPCO is experiencing significant increases in its debt service obligations during the period 1983-1988. While KEPCO is expected to meet its debt service requirements, its internal cash contribution to investment is negligible[5/] and KEPCO has to rely on external borrowing and other sources for financing. This situation is projected to continue until 1988. With the proposed rates of return and debt limitation covenants (para. 5.22), KEPCO's self-financing ratio will improve to about 40% in 1989 and remain at about 50% from 1990 onwards. This improving profile of performance is satisfactory and results mainly from reduced investment and lower debt service requirements after 1988.

K. Proposed Financial Covenants

5.22 At negotiations, KEPCO and Government agreed to take steps, including but not limited to adjusting its tariff, to enable KEPCO to achieve an annual rate of return of not less than 9% for 1986-88 and 10% for 1989 onwards on average revalued net fixed assets in operation (less consumers' contributions in aid of construction). KEPCO also agrees to maintain a minimum debt service coverage of 1.2 times except that for the three years 1986-88, the coverage will be not less than 1.0 times.

L. Financing Plan

5.23 KEPCO's forecast of sources and applications of funds is given in Annex 11. A summary of KEPCO's financing plan for the period (1986-91) is given in Table 5.5:

5/ The self-financing ratio becomes slightly negative for 1985-1988 after taking into account the increases in working capital.

Table 5.5: KEPCO's FINANCING PLAN (1986-91)

	1986-89 Billion won	%	1986-91 Billion won	%
Capital expenditure (including interest during construction)	6,255	100	10,976	100
Financed by:				
Gross internal cash generation	8,821		15,206	
Less: Debt service	8,015		11,845	
Increases in working capital	355		618	
Net internal cash generation	451	7	2,743	25
Borrowings	4,682	75	6,615	60
Other sources /a	1,122	18	1,618	15
Total	6,255	100	10,976	100

/a Including provisions for self insurance, staff severance payments and assets retirement, etc.

5.24 The financing plan for the project period (1986-89) envisages a capital expenditure of 6,255 billion won to be met 75% from foreign and local borrowings. The remaining 25% will be financed from net internal cash generation (7%) and other sources (18%); the latter represent the estimated net increase in provisions for self insurance, staff severance payments and premature retirement of assets. Instead of separate funding of these provisions, KEPCO invests them in its own plant which is a common practice of most utilities and is acceptable. In analyzing KEPCO's projected financial statements and calculating debt/equity and net fixed assets/debt ratios we have conservatively treated these provisions as part of KEPCO's long term debt. The low contribution from net internal sources during the period 1986-89 is mainly due to the relatively large increase in KEPCO's debt service requirements. However, KEPCO will have a substantially improving trend in its self-financing capability beyond 1988 (paras. 5.20 and 5.21). As shown in the financing plan for the period 1986-91, external borrowings will account for about 60% of KEPCO's investment, and net internal cash generation (25%) and funds from other internal sources (15%) will finance the remaining 40%. The above financing plan is reasonable. Given its financial standing, KEPCO is expected to have no difficulty in arranging external financing sources to support its development program.

5.25 KEPCO's borrowing strategy is likely to depend on several factors: (a) cost of borrowing; (b) availability of funds; (c) size of investment; and (d) self-generation. KEPCO has already established a good credit reputation and has developed considerable expertise in approaching the capital market. However, a cautious approach to external borrowing is still fully warranted

given the volatility of the market and the resulting impact on KEPCO's finances.

5.26 During negotiations, agreements were reached that:

(i) KEPCO would prepare, by December 31, 1986, a 10 year financing and investment plan, taking into account alternative financing sources and the associated costs. The plan would also include a study of the impact on KEPCO's finances and recommend measures, if needed, to ensure a continued improving trend of financial performance; and

(ii) KEPCO would update this plan annually and provide the Bank with a copy of the plan together with a complete set of financial projections for review and comment within three months of the beginning of each fiscal year.

5.27 For the purpose of evaluating the impact of various financing and investment plans, the study mentioned in para. 5.26 will include an analysis of KEPCO's financial performance in terms of rate of return, self-financing ratio and other relevant indicators such as debt/equity ratio, debt service and interest coverage ratios, and total net fixed assets to total debt ratio, etc.

M. Sensitivity Analysis

5.28 Given the uncertainty in the world and domestic environment, any significant changes in the critical parameters adopted for the financial forecasts (such as sales, tariffs, fuel costs and borrowing terms and conditions) will have a major impact on KEPCO's financial prospects. A number of sensitivity tests have been performed on these parameters in order to assess the magnitude of the impact of a change in these parameters on KEPCO's finances over the next five-year period (1986-1991). The results are summarized in Table 5.6.

Table 5.6: SENSITIVITY RESULTS - 1986 THROUGH 1991
(Billion won)

	Base Case	Case 1	Case 2	Case 3	Case 4
Capital expenditures (including interest during construction and nuclear fuel)	10,976	11,011	11,002	10,973	10,976
Financed by:					
Gross internal generation	15,206	14,463	14,654	15,200	15,206
Less: Principal repayments	8,411	8,678	8,654	8,404	8,324
Interest expenses	3,434	3,576	3,555	3,405	3,442
Debt services	11,845	12,254	12,209	11,809	11,766
Net internal generation	3,361	2,209	2,445	3,391	3,440
Borrowings	6,615	7,856	7,584	6,597	6,573
Other /a	1,000	946	973	985	963
Total	10,976	11,011	11,002	10,973	10,976

/a Including changes in working capital and other assets and liabilities

5.29 The base case assumes: (i) medium demand scenario (para. 6.07); (ii) annual fuel price escalation of 3%; (iii) capital expenditure as given in KEPCO's 1985 investment program; and (iv) borrowing at 10% p.a. with a 10 year repayment. Assumptions underlying the other cases are: (a) Case 1 assumes low demand scenario (para. 6.07) with no change in investment expenditures; (b) Case 2 assumes annual fuel price escalation of 5%; (c) Case 3 assumes borrowing at 9%; and (d) Case 4 assumes 15 year repayment. For all these cases the other assumptions are the same as in the base case.

5.30 From the above table, it is clear that Case 1 and Case 2 have the most significant impact in terms of net internal cash generation and borrowings. Lower sales growth from 8.3% p.a. to 7.0% p.a. over the period 1986-91 would reduce about one third of the net internal cash generation or about 1,150 billion won, and increase borrowing by about that amount. Increase in the fuel cost by 2 more percentage points would reduce the net internal cash generation by about 920 billion won. In both Case 1 and Case 2, the resulting ROR in 1989 will be about 1.5 percentage points less than in the Base Case, and the DSCR will be slightly lower (1.2 times instead of 1.3 times). A reduction in the average interest rate from 10% to 9% would imply a saving in interest expense of about 29 billion won and extending the repayment period from 10 year to 15 year would reduce the debt service requirements by about 79 billion won.

VI. PROJECT JUSTIFICATION AND RISKS

A. Justification

6.01 The project is a sequel to the Bank's Energy Sector Review (Report No. 5307-KO) carried out during 1984/1985 which addressed, inter alia, important issues in the power subsector. Most recommendations made therein were well received by GOK and KEPCO (paras. 2.14-2.15). In particular, programs for improvements in investment planning, load research and load management (paras. 2.16-2.23) to be undertaken under this project would strengthen the power sector.

6.02 The T/D component of KEPCO's investment program accounts for about 42% of the total investment during the 1986-1989 period. In the past, the Bank's attention had been focussed mainly on generation. Attention to T/D is timely in the context of future Bank lending operations which would most likely be subsector wide. As explained earlier (paras. 4.01 and 4.05) the EHV lines included in the project are necessary to ensure reliable integrated operation of generating stations which are being located increasingly distant from load centers. The T/D expansion is designed to optimally sustain the rated voltage and to reduce the frequency of failures and intervals (para. 2.10). Load flow studies and fault and dynamic analysis are performed using computer packages of PECO (Philadelphia Electric Company) and PSSE (Power System Simulator). The reliability standards are based on guidelines prepared by the U.S. National Electric Reliability Council in April 1975.

B. Economic Rate of Return

6.03 Since the T/D project consists of numerous dispersed items, its benefits are not attributable to a specific region or a specific group of consumers. It is, therefore, inappropriate to calculate the economic rate of return of this T&D project in isolation from the rest of the investment program. Accordingly, the economic rate of return was calculated for KEPCO's investment program for the period 1986-89 of which the proposed project is a part.

6.04 The internal economic rate of return (IERR) was calculated based on the incremental cost and benefit streams associated with the 1986-89 program. Investment costs were calculated for generation, transmission and distribution facilities which would be in place during this four year period. The generating plants being added amount to about 5,250 MW mainly consisting of 5 x 950 MW nuclear units and 5 multi-purpose hydro projects with total capacity of about 400 MW. Investment costs on all of these plants were traced back to their initiation stage and all the costs incurred prior to 1986 were included in the cost stream.

6.05 The IERR is 15% (details are given in Annex 13), which is higher than the opportunity cost of capital (13%). The figure of 13% is presently used by the Government as the minimum rate-of-return standard for public investment. It indicates the lowest acceptable rate of return that investment funds should earn if allocated to other projects (sectors).

Consumer Surplus

6.06 The above rate of return (para. 6.05) is based on "direct" benefits of incremental energy consumption as measured by the revenues associated with the incremental sales of electricity. To capture, at least partially, the indirect benefits of electricity consumption, consumer surplus was estimated and included in the benefit stream. Estimation of consumer surplus was carried out based on the demand functions for various customer groups developed by the Research Center. Although consumer surplus varies within customer groups and over time, its weighted average remains between 26-28% of direct benefits. When included in the benefit stream, consumer surplus raises the IERR from 15% to 19%.

Sensitivity to the Demand Forecast

6.07 The present forecast is that the demand would reach 21,500 MW in 1996 growing annually at 7.9%. Two other scenarios of demand forecast which correspond with 8.7% and 6.9% annual growth rates, have been worked out representing high and low trends (Annex 14).

6.08 To examine the sensitivity of IERR to the variations in demand forecasts, the incremental energy sales from the 1986-89 investment program were recalculated by simulating KEPCO's operations planning model based on the high and low demand scenarios. These incremental sales were then used to recalculate the direct benefits, to adjust the O&M costs and recompute IERR. The results of this sensitivity analysis are presented in the following table:

Table 6.1: IERR ON KEPCO'S 1986-89 INVESTMENT PROGRAM

	Base demand	High demand	Low demand
Consumer surplus excluded	15	16	12
Consumer surplus included	19	20	16

Return on the Long-Term Plan

6.09 KEPCO's 1986-89 investment program is part of KEPCO's 1986-96 long-term development plan. Changes in IERR which would result from extending the investment horizon from the next 4 years to the next 11 years (the Sixth and Seventh Development Plan Periods) have also been calculated (para. 6.10). In addition to the 5,250 MW which would be commissioned in 1986-89 about 6,000 MW, consisting of 10 x 500 MW coal, 1800 MW of nuclear, and 600 MW of pumped storage plant would be added during 1990-1996. Some 1,300 MW of oil based thermal plant would be retired during this period.

6.10 IERR for the long-term development plan is 14%. This rate is lower than IERR on 1986-89 investment program despite the economic advantage of coal (over nuclear) units which would be commissioned in 1992-96. This slightly lower rate of return is due to the fact that the cost of T/D facilities to be constructed after 1989 is proportionately greater. Inclusion of consumer surplus in the benefit stream would increase IERR to 18%.

6.11 The sensitivity of IERR with respect to variations in load forecast was also analyzed by recalculating the incremental energy sales from the proposed development plan based on the "high" and "low" demand scenarios. The results of this sensitivity analysis are summarized in the following table:

Table 6.2: IERR ON KEPCO'S LONG-TERM DEVELOPMENT PLAN

	Base demand	High demand	Low demand
Consumer surplus excluded	14	16	12
Consumer surplus included	18	19	16

Internal Financial Rate of Return (IFRR)

6.12 IFRR for both the 1986-89 investment program and the 1986-96 development plan were calculated by including taxes and duties in input costs and excluding the sales taxes from the revenues. IFRR for the 1986-89 investment program is 12% and for the 1986-96 development plan 11%.

C. Risks

6.13 The scope of T/D program is definitive only for 1986 and is subject to adjustments thereafter in accordance with the set Five-Year Plan goals and available resources. The only risk of any significance associated with this project is that of delay in completion on account of limitations on KEPCO's financial resources. This has been minimized by the extent to which KEPCO's earlier development programs (of 1984) have been pruned after GOK reviews during 1985 (para. 2.08). Being a T/D project, the impact of any such financial difficulty would be either a delay of some system components or a slight drop in overall efficiency, which would be acceptable given the high standards achieved by KEPCO.

VII. AGREEMENTS REACHED AND RECOMMENDATIONS

A. Agreements Reached

7.01 During negotiations the following agreements were reached:

(a) With KEPCO

(i) Within two months of their completion every year KEPCO would furnish to the Bank copies of (a) KEPCO's report to the EPB on KEPCO's performance and (b) results of EPB's evaluation of KEPCO's performance (para. 3.06);

(ii) KEPCO would submit to the Bank its annual financial statements audited by independent auditors, together with the auditors report thereon within three months of the end of each year (para. 3.13);

(iii) KEPCO would prepare and submit to the Bank a project completion report (para. 3.17);

(iv) KEPCO would provide the Bank, for its information and comment, annual technical progress reports on the entire T/D program, also pointing out any significant departures from the overall program and setting out the basis and details of the T/D Program beyond 1986 (para. 4.10);

(v) KEPCO would maintain a minimum annual debt service coverage of 1.2 times except that for 1986-1988 the coverage will be not less than 1.0 times (para. 5.22); and

(vi) KEPCO would prepare by December 31, 1986, a 10-year financing and investment plan, update it annually and provide the Bank with a copy thereof, together with a complete set of financial projections within three months of the beginning of each year (para. 5.26).

(b) With GOK and KEPCO

(i) A permanent demand forecasting committee would be formed by December 31, 1986 to review and approve KEPCO's demand forecasts and to publish the approved forecasts on an annual basis (para. 2.17);

(ii) KEPCO would complete the tariff study which was carried out under the second structural adjustment loan to overcome shortcomings determined by subsequent reviews and prepare a revised tariff schedule by December 31, 1986, for comment by the Bank and approval of GOK (para. 2.23);

(iii) GOK would meet any shortfall in funds for completion of the project (para. 4.18); and

(iv) GOK and KEPCO would take steps including but not limited to adjusting the tariffs to enable KEPCO to achieve an annual rate of return of not less than 9% for 1986-1988 and 10% for 1989 onwards on average revalued net fixed assets in operation (para. 5.22).

B. Recommendation

7.02 With the above agreements, the proposed project is suitable for a loan of $230 million for a period of 15 years including a 3-year grace period, at the standard variable interest rate, to the KEPCO with the guarantee of the Republic of Korea.

KORFA

SECOND POWER PROJECT

KEPCO's Actual Energy Sales, Generation, Peak Demand, Installed Capacity and Number of Employees

	1961	1970	1975	1980	1981	1982	1983	1984
Energy Sales and No. of Customers								
Energy sales (GWh)	1,213	7,740	16,630	32,734	35,424	37,879	42,620	47,051
Lighting	228	1,009	2,130	5,108	5,644	6,316	7,457	8,447
Small power	148	572	1,130	5,340	5,750	6,009	6,617	7,260
Large power	816	6,122	13,286	22,083	23,752	25,147	28,131	30,822
Agriculture	21	37	84	203	278	407	415	522
No. of customers	797,252	2,025,170	3,938,820	7,484,829	5,682,341	5,985,146	6,341,630	6,621,304
Lighting	770,785	1,969,618	3,830,969	5,259,034	5,402,407	5,691,213	5,996,208	6,282,902
Small power	24,702	49,824	93,588	201,545	248,296	236,064	246,799	264,821
Agriculture	45	132	2,005	2,890	3,225	3,561	4,268	4,766
Large power	1,720	5,596	12,258	21,360	28,413	54,308	94,355	68,815
Generation								
Energy sales (GWh)	1,213	7,740	16,630	32,734	35,424	37,879	42,620	47,051
T&D losses (%)	28.0	11.8	11.3	6.7	6.7	6.6	6.3	7.4
Net generation (GWh)	1,684	8,780	18,751	35,083	37,950	40,555	45,495	50,808
Auxiliary use (%)	5.0	4.2	5.5	5.5	5.2	5.0	5.6	5.6
Gross generation (GWh)	1,773	9,168	19,837	37,239	40,207	43,122	48,850	53,808
Hydro	652	1,221	1,338	1,467	1,701	1,380	2,017	1,699
Steam	1,118	7,546	15,766	29,755	32,535	35,064	35,292	39,066
Internal combustion	3	360	203	421	296	377	256	140
Nuclear	-	-	-	3,477	2,897	3,777	8,965	11,792
Purchased power (GWh)	-	41	2,530	2,119	2778	2,540	2,320	1,111
Load factor (%)	66.2	67.3	67.6	77.7	74.7	73.9	73.4	69.5
Peak Demand (MW)	306	1,555	3,351	5,457	6,144	6,661	7,602	8,811
Installed Capacity (MW)	368	2,068	4,720	9,391	9,835	10,304	13,115	14,190
Hydro	143	327	620	1,157	1,202	1,202	1,202	1,202
Steam	223	1,477	3,845	6,412	6,812	6,722	8,881	9,941
Internal combustion	2	264	255	1,235	1,234	1,114	1,116	1,131
Nuclear	-	-	-	587	587	1,266	1,916	1,916
Electricity Consumption per Capita (kWh)	45	246	480	859	915	963	1,067	1,160
KEPCO's Employees (No.)	10,095	12,440	13,959	18,526	19,579	20,849	21,424	21,994

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SECOND POWER PROJECT

Forecast of KEPCO's Energy Sales, Generation, Peak Demand and Installed Capacity

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Energy Sales (GWh)	50,580	54,626	59,160	64,130	69,452	75,356	81,610	87,650	94,048	100,913	108,381	116,401
Residential	9,809	10,943	12,176	13,516	14,927	16,440	18,055	19,732	21,476	23,341	25,348	27,516
Commercial	8,350	9261	10,132	11,098	12,109	13,366	14,578	15,751	17,003	18,371	19,859	21,474
Industrial	32,421	34,422	36,852	39,516	42,416	45,550	48,977	52,167	55,569	59,201	63,174	67,411
T&D losses(%)	6.5	6.5	6.4	6.4	6.4	6.4	6.4	6.3	6.3	6.3	6.3	6.3
Net generation (GWh)	54,096	58,424	63,205	68,515	74,201	80,509	87,190	93,543	100,371	107,698	115,668	124,227
Auxiliary use (%)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Gross generation (GWh)	57,549	62,153	67,239	72,888	78,937	85,647	92,755	99,514	106,778	114,572	123,051	132,157
Load factor (%)	71.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
Peak demand (MW)	9,253	10,136	10,965	11,887	12,873	13,967	15,126	16,229	17,413	18,684	20,067	21,552
Installed Capacity (MW)	16,161	18,083	19,133	20,283	21,293	21,173	21,268	22,163	23,108	23,823	26,073	27,263
Hydro	2,217	2.217	2,317	2,549	2,639	2,639	2,784	2,784	2,784	2,784	3,384	3,384
Oil	6,648	4,820	4,820	4,788	4,788	4,788	4,788	4,683	4,628	4,418	4,168	3,758
LNG	700	2,550	2,550	2,550	2,550	2,550	2,550	2,550	2550	2,550	2,550	2,300
Coal	3,730	3,730	3,730	3,730	3,700	3,580	3,530	4,530	5,530	6,455	7,455	8,405
Nuclear	2,866	4,766	5,716	6,666	7,616	7,616	7,616	7,616	7,616	7,616	8,516	9,416

ANNEX 3

KOREA

SECOND POWER PROJECT

KEPCO's Transmission and Distribution Facilities

	1961	1965	1970	1975	1980	1984
Transmission lines (ckm)	6,171	7,108	9,140	8,933	12,685	15,172
345 kV	-	-	-	-	2,044	3,179
154 kV	1,045	1,353	2,858	3,740	6,062	7,547
66 kV	2,199	2,884	3,448	4,061	4,484	4,414
22 kV	2,927	2,871	2,834	1,132	95	32
Substation installed capacity (MVA)	1,209	1,741	3,424	6,754	19,108	29,619
345 kV	-	-	-	-	6,[illegible]3	11,669
154 kV	373	578	1,803	4,013	9,789	15,026
66 kV	519	817	1,084	1,852	2,213	2,286
22 kV	317	346	537	889	773	638
Distribution lines (ckm)	9,171	11,864	21,002	67,365	122,919	156,867

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SECOND POWER PROJECT

KEPCO's Tariffs

Tariff Structure

Electricity tariffs are structured as multiblock progressive rates in the residential and commercial sectors and flat rates in the agricultural sector, street lighting and small industries. The large industrial consumers are, however, charged according to a peak load pricing structure which was introduced in December 1977. The rate structure is summarized in the table below:

Table 1: STRUCTURE OF TARIFFS FOR VARIOUS CUSTOMER GROUPS

Customer group	Scope of Application	Type	Ratios
Residential	Households	5 stage progressive structure	1 :6.3
Industrial	mining and manufacturing		
(small)	- contracted maximum demand of less than 500 kW.	flat rate	-
(large)	- contracted maximum demand of 500 kW and over.	peak load pricing	1 : 1.5 : 3
Business			
- Public	- government and municipal office, military office, and other noncommercial	4 stage Progressive Structure	1: 1.5
- Commercial	- other than public	ditto	1 : 2.2
Agricultural	irrigation, orchard, livestock raising etc.	flat rate	-
Street Lighting	street and park lighting	flat rate	-

Present Rates

Present electricity rates for various customer groups are summarized in Table 2 of this Annex.

Table 2: PRESENT ELECTRICITY RATES FOR VARIOUS CUSTOMER GROUPS

Sector	Basic charge	Energy charge
Residential	- W 338/customer for the use of 100 kWh or less per month	- W 31.90/kWh for the first 50 kWh/month
	- W 676/customer for the use of 101-300 kWh per month	- W 75.71/kWh for the next 50 kWh
	- W 1,014/customer for the use of more than 300 kWh per month	- W 102.07/kWh for the next 50 kWh
		- W 148.01/kWh for the next 150 kWh
		- W 202.35/kWh for the excess over 300 kWh/month
Small Industrial	W 3,495 per kW of contracted demand	- W 52.12/kWh
Large Industrial:		
500-1,000 kW and 10-140 kV	W 2,953 per kW of contracted demand	- W 93.55/kWh during the peak hours - W 46.50/kWh during the shoulder hours - W 31.20/kWh during the off peak hours
over 1,000 kW and over 140 kV	W 1,973 per kW of contracted demand	- W 88.75/kWh during the peak hours - W 48.85/kWh during the shoulder hours - W 29.60/kWh during the off peak hours
Commercial	W 4.045 per kW of contracted demand	- W 82.68/kWh for the first 90 hours of contracted demand - W 119.85/kWh for the next 45 hours - W 154.09/kWh for the next 45 hours - W 181.90/kWh for the excess over 180 hours
Public	W 4.045 per kW of contracted demand	- W 78.76/kWh for the first 90 hours of contracted demand - W 92.06/kWh for the next 45 hours - W 105.60/kWh for the excess over 180 hours
Agricultural:		
Irrigation	W 321 per kW of contracted demand	W 20.35/kWh
Crops	W 871 per kW of contracted demand	W 26.00/kWh
Breeding, etc.	W 1,019 per kW of contracted demand	W 35.80/kWh
Street Lighting	W 3.721 per kW of contracted demand	W 71.48/kWh

Note: Peak hours are 7:00 - 10:00 pm in March through September and 5:00 - 10:00 pm in October through February, shoulder hours are 6:00 am - 7:00 pm in March through September and 6:00 am - 6:00 pm in October through February.

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SECOND POWER PROJECT

Institutions in the Energy Sector and the Power Subsector

Institutions in the Energy Sector

1. The Ministry of Energy and Resources (MER), created in 1978, is responsible for the overall coordination of the energy sector. Also affiliated with MER are:

(a) Korean Institute of Geoscience and Mineral Resources (KIGAM), which explores and surveys mineral and energy resources;

(b) Korean Mining Promotion Corporation (KMPC) which assists the mining industry and administers the coal mining subsidy program set in the late 1960s;

(c) Korean Oil Development Corporation (KODC), established in 1979, which is responsible for oil related activities including development, production, storage, processing and supply/demand issues;

(d) Korea Petroleum Development Company (PEDCO), created in 1980, to attract petroleum operators to participate in exploration/ development in Korea and abroad;

(e) Korea Gas Corporation (KGC), established in 1983, to carry out the overall planning and implementation of the gas transmission and distribution systems including the construction of the terminal and transmission pipelines to Seoul/Incheon and the supply of gas to the system; and

(f) Korea Electric Power Corporation (KEPCO), which was established in 1961, to develop power resources and generate, transmit and distribute electricity throughout the country.

2. In addition to MER and its affiliates several other ministries and public entities are involved in the management of the energy sector. The most important of these are: (a) Ministry of Science and Technology (MOST), established in 1967, which has significant energy related functions including the administration of the nuclear energy program in Korea; and (b) Economic Planning Board (EPB), which is in charge of integrating economic and energy policy. Also affiliated with MOST, are the Atomic Energy Bureau (AEB) and Korea Advanced Energy Research Institute (KAERI). The interministeral coordination of energy policy formulation and implementation is the responsibility of the Energy Policy Reviewing Committee whose members include vice ministers of EPB, MER, MOST, Ministries of Construction, Commerce and Industry, Finance, Home Affairs, and Transportation as well as presidents of

KEPCO, KAERI, KIGAM, Korean Development Institute, and Industrial Site and Water Development Company (ISWACO).

3. The institutions in the power subsector have been described in paras. 2.07-2.08. The Government has recently (July 1984) established an Electric Power Group Coordination Council (EPGCC) whose main objective is coordinating of the major development strategies in the power sector. The council deliberates on power development programs and makes recommendations on them. It also fosters self reliance in technical matters including standardization of coal fired plants and their construction. The council meets every three months. KEPCO's president is the chairman of the council; the other members are the chief executives of the following organizations:

(a) Korea Heavy Industries and Construction Co. Limited (KHIC) which manufactures various kinds of equipment and components for hydro, thermal and nuclear plants. KHIC also builds industrial plants such as cement, steel, petro-chemicals, off-shore structures and salinating plants. KHIC is a subsidiary of KEPCO.

(b) Korea Power Engineering Co. Limited (KOPEC) which provides consulting services for design and engineering of power generating facilities including nuclear power plants.

(c) Korea Electric Power Operating Service Co. Limited (KEPOS) which undertakes maintenance of power plants, transmission and distribution facilites and industrial facilities.

(d) Korea Nuclear Fuel Co. Limited (KNFC), which is responsible for localization of the fabrication of light water reactor fuel.

(e) Korea Advanced Energy Research Institute (KAERI) which works under the Ministry of Science and Technology and is GOK's prime institution for research in atomic energy.

(f) Korea Electric Safety Corporation (KESCO) which carries out research on electric hazards and develops safeguards against them.

(g) Korea Gas Company (KGC) formed in August 1983 to handle the LNG imported from Indonesia for power generation and for household consumption will soon be the eighth member of the EPGCC.

ANNEX 6

KOREA

SECOND POWER PROJECT

Long-Term Expansion Program of KEPCO's Generation Facilities (1986-96)

Year/month		Plant	Capacity	Total capacity (MW)	Capability
1986	June	Nuclear #6	950		
	June	Jeju diesel	5x4		
	June	Ulrungdo diesel	1x2		
	December	Nuclear #7	950	18,083	14,129
1987	June	Hapchon Hydro	100		
	September	Nuclear #8	950	19,133	15,758
1988	June	Imgye Hydro	160		
	June	Imha Hydro	50		
	June	Juam Hydro	23		
	September	Nuclear #9	950		
		Retire	-32	20,283	16,789
1989	June	Hongchon Hydro	90		
	September	Nuclear #10	950		
		Retire	-30	21,293	17,648
1990		Retire	-120	21,173	18,541
1991	April	Kangrung Hydro	82		
	June	Hamyang Hydro	13		
	June	Myongchon Hydro	50		
		Retire	-50	21,268	18,508
1992	March	Coal thermal #5	500		
	September	Coal thermal #6	500		
		Retire	-105	22,163	18,899
1993	March	Coal thermal #7	500		
	September	Coal thermal #8	500		
		Retire	-55	23,108	19,566
1994	March	Coal thermal #9	500		
	September	Coal thermal #10	500		
		Retire	-285	23,823	20,673
1995	March	Coal thermal #11	500		
	March	Nuclear #11	900		
	June	Muju Pumped St.	600		
	September	Coal thermal #12	500		
		Retire	-250	26,073	22,307
1996	March	Coal thermal #13	500		
	March	Nuclear #12	900		
	June	Coal thermal #14	500		
		Retire	-710	27,263	23,919

KOREA

SECOND POWER PROJECT

Salient Particulars of Expansion of Transmission Lines, Sub-stations and Distribution Lines (1986-1989)

1. 345 kV Transmission Facilities

Year	From - To	Circuits x length (km)	Total (C-km)
1986	Sin Jechon - Donghe	2 x 98	
	Yongkwang - Chongyang	2 x 170	
	Sin Jechon - Sin Pohang	2 x 210	956
1987	Donghe - Uljin	2 x 55	
	Sin Inchon Branch	4 x 1	114
1988	Uljin - Yongju	2 x 90	180
1989	Uijongbu - Goyang	2 x 25	
	Goyang - Inchon	2 x 30	
	Buk Busan - Nam Busan (UG)	2 x 20	150

2. 345 kV Substation Facilities

Year	Substation	No. of Banks (500 MVA)	MVA
1986	Sin Kwangju #1		
	Donghe #1		
	Uijongbu #2		
	Heunde #2	4	
	Stand-by (1 phase)	2/3	2,333
1987	Chongyang #1		
	Sin Inchon #1		
	Sin Kwangju #2	3	
	Stand-by (1 phase)	1/3	1,667
1988	So Seoul #2		
	Sin Masan #2	2	1,000
1989	Goyang #1		
	Nam Busan #1		
	Donghe #2	3	1,500

3. Expansion Planning of Transmission and Distribution Facilities

		1986	1987	1988	1989	Total
Transmission Facilities:						
Line length: ckm:	345 kV	956	114	180	150	1,400
	154 kV	520	500	394	375	1,789
	66 & 22 kV		-32		-100	-132
	Total	1,476	582	574	425	3,057
Substation Facilities:						
Installed capacity: MVA:	345 kV	2,333	1,677	1,000	1,500	6,500
	154 kV	1,600	1,360	1,400	1,400	5,760
	66 & 22 kV	-100	-71	-76	-50	-297
	Total	3,833	2,956	2,324	2,850	11,963
Distribution Facilities:						
Route length (ckm)		6,588	5,029	5,156	5,109	21,882
Transformers (MVA)		836	791	824	862	3,313

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SECOND POWER PROJECT

Annual Project Expenditures /a
(U.S. $ million)

	1986			1987			1988			1989			Total		
	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total
Transmission	159.0	57.0	216.0	155.0	50.0	204.0	131.0	56.0	187.0	68.0	36.0	104.0	513.4	198.7	712.0
Substation	74.0	76.0	149.0	62.0	64.0	126.0	56.0	58.0	114.0	61.0	60.0	121.0	252.9	257.9	510.8
Distribution	243.0	90.0	334.0	219.0	83.0	303.0	252.0	90.0	343.0	279.0	97.0	376.0	992.8	360.1	1,352.8
Research	-	-	-	-	-	-	2.0	4.0	6.0	3.0	4.0	7.0	5.0	10.0	15.0
Engineering	0.5	-	0.5	0.4	0.1	0.5	-	-	-	-	-	-	0.9	0.1	1.0
Technical assistance	0.1	-	0.1	0.2	0.1	0.3	0.2	0.1	0.3	0.2	0.1	0.3	0.7	0.3	1.0
Total Base Cost	476.6	223.0	699.6	436.6	197.2	633.8	441.2	208.1	649.3	411.2	197.1	608.3	1,765.7	827.1	2,592.7
Physical contingencies	20.0	12.0	32.0	18.5	10.5	29.0	18.0	11.0	29.0	16.0	10.0	26.0	72.1	43.0	115.1
Price contingencies	22.0	17.0	39.0	41.0	31.0	72.0	63.0	50.0	113.0	78.0	65.0	143.0	205.4	162.7	368.1
Total Project Cost	518.6	252.0	770.6	496.1	238.7	734.8	522.2	269.1	791.3	505.2	272.1	777.3	2,043.2	1,032.8	3,075.9

/a Excluding interest during construction but including taxes and duties in the amount of $388.0 million.

KOREA

SECOND POWER PROJECT

Schedule of Disbursement

Bank FY	Semester	Disbursement in $ million		Disbursement as % of total	Bank profile
		Semester	Cumulative		
1986	II	1.5	1.5	0.6	3.3
1987	I	21.0	22.5	9.8	8.3
	II	22.5	45.0	19.6	15.2
1988	I	22.5	67.5	29.3	23.9
	II	22.5	90.0	39.1	34.0
1989	I	35.0	125.0	54.3	44.9
	II	35.0	160.0	69.6	55.8
1990	I	35.0	195.0	84.8	66.2
	II	35.0	230.0	100.0	75.3

ANNEX 10
Table 1

KOREA

SECOND POWER PROJECT

Korea Electric Power Corporation (KEPCO)

Historical Income Statements
(Won billion)

Fiscal year ending December 31,	1979	1980	1981	1982	1983	1984
Sales of electricity (GWh)	31,145	32,734	35,424	37,880	42,620	47,051
Increase over previous year (%)	14.00	5.10	8.20	6.90	12.50	10.40
Average revenue per kWh sold (Won)	32.17	51.17	64.61	69.87	67.71	67.42
Average revenue per kWh (US cents)	6.33	7.73	9.23	9.10	8.56	8.23
Operating Revenues						
Revenue from electricity sales	1,002	1,675	2,289	2,658	2,896	3,181
Other operating revenues	5	2	2	3	3	3
Total Operating Revenues	1,007	1,677	2,291	2,661	2,899	3,184
Operating Expenses						
Fuel	416	847	1,234	1,446	1,330	1,229
Purchased power	46	66	101	111	100	51
Personnel expenses	84	92	126	137	212	154
Depreciation	79	105	131	276	350	514
Maintenance and other expenses	80	124	157	138	235	295
Taxes	23	33	35	51	81	105
Total Operating Expenses	728	1,267	1,784	2,159	2,308	2,348
Operating Income	279	410	507	502	591	836
Nonoperating income (net) /a	(4)	(22)	(51)	(75)	(78)	(190)
Net income before interest	275	388	456	427	513	646
Interest Expense						
Gross interest	129	269	409	485	509	577
Less interest charged to construction	(61)	(112)	(183)	(241)	(222)	(208)
Net Interest	68	157	226	244	287	369
Net Income	207	231	230	183	226	277
Rate of Return (%) /b						
On average net fixed assets plus working capital provision and 100% of average work-in-progress	10.1	8.7	8.5	7.2	7.2	9.0
On average net fixed assets	17.2	12.9	14.3	14.8	13.7	14.9
Interest coverage ratio (times)	4.0	2.5	2.0	1.8	1.8	1.8

/a Includes amortization of foreign exchange losses and other nonoperating income/ expenses.
/b Revalued assets less consumers' contributions in aid of construction.

ANNEX 10
Table 2

KOREA

SECOND POWER PROJECT

Korea Electric Power Corporation (KEPCO)

Historical Balance Sheets
(Won billion)

	1979	1980	1981	1982	1983	1984
Assets						
Fixed Assets						
Gross fixed assets in service	1,967	2,443	2,675	5,450	7,333	8,638
Less accumulated depreciation	(537)	(629)	(748)	(2,104)	(2,374)	(2,853)
Net Fixed Assets in Service	1,430	1,814	1,927	3,346	4,959	5,785
Work-in-progress	976	1,514	2,544	3,840	3,312	3,513
Total Fixed Assets	2,406	3,328	4,471	7,186	8,271	9,298
Nuclear fuel	12	62	65	80	224	230
Current Assets						
Cash	31	80	92	97	63	72
Customers' receivables	90	154	182	203	253	245
Inventories	86	151	201	212	233	199
Other current assets	65	96	113	60	85	122
Total Current Assets	272	481	588	572	634	638
Deferred and other assets	50	523	552	597	705	587
Investment in KHIC, KOPEC and others	-	-	102	102	136	148
TOTAL ASSETS	2,740	4,394	5,778	8,537	9,970	10,901
Liabilities						
Equity						
Capital	468	500	625	1,588	1,603	1,603
Revaluation reserve /a	62	62	62	1,485	1,485	1,485
Retained earnings including consumers'contributions	404	713	981	233	517	858
Total Equity	934	1,275	1,668	3,306	3,605	3,946
Long-Term Debt						
Gross long-term debt	1,524	2,696	3,618	4,647	5,570	6,123
Less current maturities	(148)	(303)	(497)	(610)	(884)	(1,110)
Net Long-Term Debt	1,376	2,393	3,121	4,037	4,686	5,013
Current Liabilities						
Current maturities	148	303	497	610	884	1,110
Other current liabilities	159	277	314	365	435	421
Total Current Liabilities	307	580	811	975	1,319	1,531
Other liabilities /b	123	146	178	219	360	411
TOTAL LIABILITIES	2,740	4,394	5,778	8,537	9,970	10,901
Debt/equity ratio /c	62/38	67/33	66/34	56/44	58/42	58/42
Fixed assets/debt ratio (times) /d	1.6	1.3	1.4	1.7	1.6	1.7

/a Revaluation of assets carried out in books in 1982.
/b Staff severance liability, self-insurance, etc.
/c Counting other liabilities as part of long term debt.
/d Total net fixed assets divided by the sum ofnet long term debt and other liabilities.

ANNEX 10
Table 3

KOREA

SECOND POWER PROJECT

Korea Electric Power Corporation (KEPCO)

Historical Sources and Applications of Funds
(Won billion)

	1979	1980	1981	1982	1983	1984
Sources of Funds						
Internal Sources						
Operating and other income	275	388	456	427	513	646
Consumers' contributions	33	88	44	49	59	64
Depreciation and amortization	83	109	204	358	423	669
Less dividends /a	(19)	(10)	(7)	-	-	-
Total Internal Sources	372	575	697	834	995	1,379
External Sources						
Equity	39	32	125	18	15	-
Borrowing	652	906	985	1,390	1,560	1,393
Total Sources of Funds	1,063	1,513	1,807	2,242	2,570	2,772
Applications of Funds						
Capital Expenditure (including interest charged to construction)	803	1,077	1,272	1,648	1,661	1,647
Investment in KHIC, KOPEC and others	-	-	102	-	34	12
Debt Service						
Principal payment	171	147	293	484	637	908
Gross interest	129	269	409	485	509	577
Gross Debt Service	300	416	702	969	1,146	1,485
Less interest charged to construction	(61)	(112)	(183)	(241)	(222)	(208)
Net Debt Service	239	304	519	728	924	1,277
Increase (decrease) in working capital	2	91	70	(67)	(8)	18
Changes in other items	19	41	(156)	(67)	(41)	(182)
Total Applications of Funds	1,063	1,513	1,807	2,242	2,570	2,772
Debt service coverage	1.6	1.9	1.3	1.1	1.1	1.1
Contribution to investment (%) /b	17	22	9	11	6	5

/a Dividend payments to nongovernment shareholders. The government's share of dividends was reinvested in the company. No dividends have been declared after incorporation of KEPCO in 1982.

/b (Total internal sources less debt service minus increase or plus decrease in working capital excluding cash) x 100 and divided by 3 years' moving average capital expenditures.

KOREA

SECOND POWER PROJECT

ANNEX 11
TABLE 1

KEPCO

INCOME STATEMENTS

(Billion Won)

Fiscal Year	Estimate 1984/85	Projection 1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
Energy sales (GWh)	50580	54626	59160	64130	69452	75356	81610
Sales increase (%)	7.50	8.00	8.30	8.40	8.30	8.50	8.30
Ave. tariff Won/kWh	67.42	68.18	71.93	75.89	80.06	80.06	80.06
Ave. price inc (%)	0.00	1.13	5.50	5.50	5.50	0.00	0.00
Operating revenues							
Energy revenue	3410.05	3724.44	4255.42	4866.62	5560.37	6033.04	6533.74
Other oper rev	3.00	3.00	4.00	5.00	5.00	6.00	6.00
Subtotal	3413.05	3727.44	4259.42	4871.62	5565.37	6039.04	6539.74
Operating expenses							
Fuel/bulk power	1276.00	1278.00	1490.00	1543.00	1593.00	1651.00	1778.00
Power purchased	95.00	114.00	115.00	138.00	161.00	173.00	190.00
Personnel expense	197.00	221.00	248.00	275.00	306.00	338.00	374.00
Repair/maintenance	109.00	135.00	172.00	202.00	234.00	268.00	294.00
Depreciation	542.00	705.00	886.00	1046.00	1217.00	1364.00	1488.00
Taxes	97.00	112.00	105.00	145.00	219.00	259.00	298.00
Other	294.00	354.00	415.00	481.00	557.00	639.00	716.00
Subtotal	2610.00	2919.00	3431.00	3830.00	4287.00	4692.00	5138.00
Operating income	803.05	808.44	828.42	1041.62	1278.37	1347.04	1401.74
Non-oper income (net)	-124.00	-153.00	-156.00	-152.00	-32.00	16.00	22.00
Net income before interest	679.05	655.44	672.42	889.62	1246.37	1363.04	1423.74
Total interest	669.64	655.24	724.71	745.41	691.47	593.75	524.75
less: I.D.C.	226.85	141.33	127.09	118.39	86.80	16.12	11.20
Interest to operation	442.79	513.91	597.62	627.02	604.67	577.63	513.55
Net income	236.26	141.52	74.79	262.60	641.69	785.41	910.19
Rate base (revalued) a/	6149.46	7863.20	9733.64	11078.09	12347.26	12986.04	13084.75
Rate of return (%)	13	10	9	9	10	10	11
Operating ratio (%)	76	78	81	79	77	78	79

a/ Average revalued net fixed assets in services, less consumers' contributions in aid of construction.

KOREA

SECOND POWER PROJECT

KEPCO

BALANCE SHEETS

(Billion Won)

ANNEX 11
TABLE 2

Fiscal Year	Estimate 1984/85	Projection 1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
ASSETS							
Fixed assets							
Plant in service	10283.00	13604.00	16186.00	18906.00	21785.00	23704.00	26005.00
less: Accum depreciation	3356.00	4227.00	5324.00	6624.00	8131.00	9846.00	11814.00
Operating plant	6927.00	9377.00	10862.00	12282.00	13654.00	13858.00	14191.00
Work in progress	3465.00	2591.00	2264.00	1574.00	807.00	1576.00	3273.00
Total fixed assets	10392.00	11968.00	13126.00	13856.00	14461.00	15434.00	17464.00
Nuclear fuel	335.00	483.00	575.00	682.00	775.00	760.00	728.00
Current assets							
Cash and bank	145.00	167.00	223.00	256.00	291.00	369.00	406.00
Consumer acct/recv	261.59	285.71	326.44	373.33	426.55	462.81	501.22
Inventories	201.00	223.00	248.00	278.00	312.00	352.00	423.00
Other	100.00	105.00	110.25	115.76	121.55	127.63	134.01
Total current assets	707.59	780.71	907.69	1023.09	1151.10	1311.44	1464.23
Other assets a/	889.00	768.00	630.00	496.00	459.00	473.00	489.00
TOTAL ASSETS	12323.59	13999.71	15238.69	16057.09	16846.10	17978.44	20145.23
EQUITY AND LIABILITIES							
Equity							
Paid-in capital	1603.00	1603.00	1603.00	1603.00	1603.00	1603.00	1603.00
Retained earnings	925.00	1066.52	1141.32	1403.92	2045.61	2831.02	3741.21
Revaluation surplus	1545.26	2290.26	3123.26	4010.26	4804.26	5572.26	6380.26
Consumers contribution	231.00	311.00	389.00	480.00	583.00	704.00	840.00
Total equity	4304.26	5270.78	6256.57	7497.18	9035.87	10710.28	12564.47
Long term debt (LtD)	7106.34	7663.48	7737.20	7108.45	6117.09	5299.16	5310.66
less: Current portion	1166.57	1308.46	1671.77	1524.86	1414.72	1324.42	1000.00
Net long term debt	5939.77	6355.02	6065.43	5583.59	4702.37	3974.74	4310.66
Current liabilities							
Current portion of LtD	1166.57	1308.46	1671.77	1524.86	1414.72	1324.42	1000.00
Accounts payable	409.00	429.45	450.92	473.47	497.14	522.00	548.10
Total current liab	1575.57	1737.91	2122.69	1998.33	1911.86	1846.42	1548.10
Other liabilities	504.00	636.00	794.00	978.00	1196.00	1447.00	1722.00
TOTAL EQUITY AND LIAB	12323.59	13999.71	15238.69	16057.09	16846.10	17978.44	20145.23
Current ratio (times)							
With curnt LT debt	0.45	0.45	0.43	0.51	0.60	0.71	0.95
Without	1.73	1.82	2.01	2.16	2.32	2.51	2.67
Debt of Debt+Equity (%)							
With reval reserve	60	57	52	47	39	34	32
Without	74	75	75	72	66	59	57
Net Fx ast / debt (times)	1.61	1.71	1.91	2.11	2.45	2.85	2.89
Accts receivable (days)	28	28	28	28	28	28	28

a/ Including investments in other subsidiaries, which is assumed constant in the projections and would become from about 2.5% in 1984 to less than 1% of KEPCO's total net fixed assets by 1991.

KOREA

SECOND POWER PROJECT

KEPCO

FUNDS FLOW STATEMENTS

(Billion Won)

ANNEX 11
TABLE 3

Fiscal Year	Estimate 1984/85	Projection 1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1985/86-1990/91 Total	%
SOURCES OF FUNDS									
Internal generation									
Net income before interest	679.05	655.44	672.42	889.62	1246.37	1363.04	1423.74	6250.63	
Depreciation	716.00	973.00	1189.00	1378.00	1465.00	1601.00	1740.00	8346.00	
Consumers contribution	59.00	80.00	78.00	91.00	103.00	121.00	136.00	609.00	
Total internal generation	1454.05	1708.44	1939.42	2358.62	2814.37	3085.04	3299.74	15205.63	64.87
External borrowings									
Total borrowings	1990.85	1723.71	1382.18	1043.02	533.50	596.79	1335.92	6615.12	28.22
Changes in other ast/liab	-61.00	253.00	296.00	318.00	255.00	237.00	259.00	1618.00	6.90
TOTAL SOURCES	3383.89	3685.15	3617.59	3719.64	3602.87	3918.83	4894.67	23438.75	100.00
APPLICATIONS OF FUNDS									
Capital expenditures									
Construction expenditure (Including IDC)	1852.00	1952.00	1606.00	1328.00	1369.00	1791.00	2930.00	10976.00	
Total capital expenditures	1852.00	1952.00	1606.00	1328.00	1369.00	1791.00	2930.00	10976.00	46.83
Debt services									
Debt repayment	1007.51	1166.57	1308.46	1671.77	1524.86	1414.72	1324.42	8410.80	
Interest	442.79	513.91	597.62	627.02	604.67	577.63	513.55	3434.42	
Total debt services	1450.30	1680.48	1906.08	2298.79	2129.53	1992.35	1837.97	11845.21	50.54
Changes in working capital	81.59	52.67	105.51	92.85	104.33	135.48	126.69	617.54	2.63
TOTAL APPLICATIONS	3383.89	3685.15	3617.59	3719.64	3602.87	3918.83	4894.67	23438.75	100.00
Intst coverage ratio (times)	1.5	1.3	1.1	1.4	2.1	2.4	2.8	1.82	
Annual debt services coverage ratio (times)	1.0	1.0	1.0	1.0	1.3	1.5	1.8	1.28	
Self-financing ratio (%)									
Annual	-0.26	-0.14	-1.01	.00	44.96	57.80	46.83	27.37	
3-year ave (w W/C less cash) a/	-0.27	-0.15	-0.99	.00	41.14	51.00	50.07		
(w/o W/C)	0.21	1.55	2.05	4.17	45.78	53.83	53.34		
Total capital expenditures: 3-year averages (prevs+curnt+folwg)	1817.00	1803.33	1628.67	1434.33	1496.00	2030.00	2740.33		

a/ (total internal sources less debt service and increase in working capital excluding cash) x 100 and divided by average of 3 years (previous, current and following) capital expenditures.

KOREA

SECOND POWER PROJECT

Notes and Assumptions Adopted for Financial Forecasts

The following inflation rates are adopted in the financial projections:

	1986	1987	1988	1989	1990	1991
Local	5.0	5.5	5.5	5.5	5.5	4.5
Foreign	7.0	7.0	7.5	7.7	7.6	4.5

(a) Income Statements

(i) Electricity Sales are based on KEPCO's revised July 1985 "Long-Range Power Development and Financial Plan" as reviewed by the Appraisal mission.

(ii) Operating Revenues have been derived by assuming that average electricity rates will be increased each year until 1989 to compensate for domestic inflation, and remain unchanged from 1990 onwards.

(iii) Fuel KEPCO's current price estimates have been increased by 1% p.a. for nuclear (heavy and light-water) and for coal. For LNG and oil a 3% annual increase in prices has been assumed.

(iv) Purchased power costs are based on KEPCO's current price estimates (July 1985 Plan) of purchases escalated according to estimates of domestic inflation in Korea.

(v) Personnel Expenses (including Accrued Retirement) are based on KEPCO's current price estimates (July 1985 Plan), escalated according to estimates of domestic inflation in Korea. Number of employees, excluding construction staff assumed for each year are as follows:

1985	19,775
1986	20,763
1987	21,341
1988	21,915
1989	22,415
1990	22,628
1991	22,856

(vi) Maintenance and Other Expenses have been escalated using estimated domestic inflation in Korea. Other expenses include amortized nuclear fuel costs.

(vii) Depreciation Expense calculations have been based on KEPCO's existing depreciation rates i.e. assuming an average life of 18 years. Additions have been depreciated at half rates in the year in which they are first taken up as part of assets in service.

(viii) Tax calculations assume the existing income tax at an average annual rate of 14.875% of taxable income during the period of the forecasts.

(ix) Interest Expense has been based on the rate of interest for foreign and local borrowing for different types of projects. The average annual rates for the forecasts are:

1986	8.86%
1987	9.53%
1988	10.21%
1989	10.61%
1990	10.48%
1991	9.62%

(x) Interest during construction (IDC) is based on KEPCO's investment program and the associated financing plan. KEPCO follows the practice of capitalizing IDC applicable to projects where the construction period is over one year.

(b) Balance Sheet

(i) Gross Fixed Assets in Service, Accumulated Depreciation revalued in 1977 (9.3%) and in 1978 (11.3%) in accordance with government regulations. Revaluation is carried out when the cumulative wholesale price index exceeds 25%. Land has been revalued by "Taxation Standard Price Valuation Method" based on the rates established by the Ministry of Home Affairs for taxation purposes. Other fixed assets have been revalued using wholesale price indices. The last revaluation was carried out in 1982 which increased the asset book value by about 100%. For 1986-1991 gross fixed assets and accumulated depreciation are annually revalued by 6.3% p.a. based on domestic and foreign estimated inflation rates.

(ii) Nuclear fuel is shown as a fixed asset item. It is amortized approximately over three years, following the industry's practice.

(iii) Current Assets

- Customers' receivables represent four week's sales.
- Inventories have been projected on the basis of power sales growth (90% of the power sale growth rate) and escalated using same domestic inflation rates.

(iv) Deferred and Other Assets are based on KEPCO's estimates of foreign exchange losses to be amortized and the investments in subsidiaries.

(v) Capital is assumed constant throughout the projection; no further capital contribution by the government is assumed.

(vi) Revaluation Reserve includes the amounts for revaluation of gross fixed assets net of revalued accumulated depreciation.

(vii) Accounts Payable/Other Liabilities are escalated using the same domestic inflation rates.

(viii) Repayment conditions are as follows:

Type	Grace period	Redemption period
Cash loan	4	4
National investment fund	1	5
Korean development bank	3	5
Korean exchange bank	1	3
Local bond	3	1
Foreign bond	4	4
Foreign Loan		
Hydro	5	10
Thermal	4	10
Nuclear	7	10
Other	2	10

KORRA

SECOND POWER PROJECT

Calculation of the Internal Economic Rate of Return

	Investment costs (US$ mln)				Operations and maintenance costs (US$ mln)					Fuel costs (US$ mln)	Total costs 4+9+10=	Energy sales (GWh)	Sales revenue (US$ mln)	Net benefits 13-11
	Generation (1)	Transmission (2)	Distribution (3)	Total (4)	Generation (5)	Transmission (6)	Distribution (7)	Other (8)	Total (9)	(10)	(11)	(12)	(13)	(14)
1978	93.1	-	-	93.1	-	-	-	-	-	-	93.1	-	-	-93.1
1979	230.5	-	-	230.5	-	-	-	-	-	-	230.5	-	-	-230.5
1980	341.8	-	-	341.8	-	-	-	-	-	-	341.8	-	-	-341.8
1981	560.8	-	-	560.8	-	-	-	-	-	-	560.8	-	-	-560.8
1982	809.6	-	-	809.6	-	-	-	-	-	-	809.6	-	-	-809.6
1983	857.9	-	-	857.7	-	-	-	-	-	-	857.7	-	-	-857.7
1984	824.9	-	-	824.9	-	-	-	-	-	-	824.9	-	-	-824.9
1985	746.5	-	-	746.5	-	-	-	-	-	-	746.5	-	-	-746.5
1986	607.6	353.0	300.0	1,260.6	31.4	11.3	41.5	53.3	137.5	65.8	1,463.9	7,327	631.8	-889.5
1987	341.4	284.8	245.5	871.7	69.1	24.9	91.3	117.3	302.6	140.3	1,314.6	16,119	1,390.1	-50.9
1988	93.6	232.2	241.4	567.2	78.5	28.3	103.7	133.3	343.8	159.2	1,070.2	18,316	1,579.5	365.7
1989	50.7	203.6	293.5	547.8	113.0	40.7	149.3	191.9	494.9	235.1	1,277.8	26,375	2,274.5	789.9
1990	-	-	-	-	119.3	43.0	157.6	202.6	522.5	249.1	771.6	27,840	2,400.7	1,410.9
1991	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
1992	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
1993	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
1994	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
1995	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
1996	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
1997	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
1998	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
1999	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
2000	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
2001	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
2002	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
2003	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
2004	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
2005	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
2006	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
2007	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
2008	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
2009	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
2010	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
2011	-	-	-	-	122.4	44.1	161.7	207.9	536.1	256.1	792.2	28,572	2,463.9	1,447.7
2012	-	-	-	-	81.6	29.4	107.8	138.6	357.4	170.6	528.0	19,048	1,642 5	965.3
2013	-	-	-	-	40.8	14.7	53.9	69.3	178.7	90.8	269.5	9,524	821.3	477.1
2014	-	-	-	-	40.8	14.7	53.9	69.3	178.7	90.8	269;5	9,524	821.3	477.1

IERR = 14.8%

KOREA

SECOND POWER PROJECT

Calculation of the Internal Economic Rate of Return

Main Assumptions

General

Costs and benefit figures contained in Table 1 of this Annex correspond with the "base case" where calculation of electricity benefits and O&M costs is predicated on the "base scenario" of the load forecast and consumer surplus is not included in the stream of benefits.

All costs and benefits are expressed in 1985 constant dollars.

Investment Costs

Generation investment costs are for the projects scheduled to be commissioned during the period 1986-89. T&D investment costs are based on KEPCO's 1986-89 investment program.

Operations and Maintenance Costs

Operation and maintenance costs are based on the actual cost figures in 1984. Fuel requirements were calculated by simulating KEPCO's operations planning model. The fuel requirements were then fed into KEPCO's "fuel cost model" which takes account of the purchase price of the nuclear fuel as well as the costs involved in the conversion, enrichment, fabrication and disposal of the fuel.

Energy Sales and Revenues

Incremental energy generation was produced by simulating KEPCO's operations planning model. Incremental energy sales were calculated by adjusting the incremental energy generation for T&D losses and auxiliary energy consumption. Average price of electricity was assumed to remain, in real terms, at its 1984 level.

ANNEX 14
Table 1

KOREA

SECOND POWER PROJECT

Forecast of Electricity Demand: Base Case

Year	Residential		Commercial		Industrial		Total	
	GWh	%	GWh	%	GWh	%	GWh	%
1984 (Actual)	8,757	13.1	7,472	13.9	30,823	8.9	47,051	10.4
1985	9,809	12.0	8,350	11.8	32,421	5.2	50,580	7.5
1986	10,943	11.6	9,261	10.9	34,422	6.2	54,626	8.0
1987	12,176	11.3	10,132	9.4	36,852	7.1	59,160	8.3
1988	13,516	11.0	11,098	9.5	39,516	7.2	64,130	8.4
1989	14,927	10.4	12,109	9.1	42,416	7.3	69,452	8.3
1990	16,440	10.1	13,366	10.4	45,550	7.4	75,356	8.5
1991	18,055	9.8	14,578	9.1	48,977	7.5	81,610	8.3
1992	19,732	9.3	15,751	8.0	52,167	6.5	87,650	7.4
1993	21,476	8.8	17,003	8.0	55,569	6.5	94,048	7.3
1994	23,341	8.7	18,371	8.0	59,201	6.5	100,913	7.3
1995	25,348	8.6	19,859	8.1	63,174	6.7	108,381	7.4
1996	27,516	8.5	21,474	8.1	67,411	6.7	116,401	7.4

ANNEX 14
Table 2

KOREA

SECOND POWER PROJECT

Forecast of Electricity Demand: High Case

Year	Residential		Commercial		Industrial		Total	
	GWh	%	GWh	%	GWh	%	GWh	%
1984 (actual)	8,757	13.1	7,472	13.9	30,823	8.9	47,051	10.4
1985	9,809	12.0	8,350	11.8	32,421	5.2	50,580	7.5
1986	11,008	12.2	9,235	10.6	34,889	7.6	55,132	9.0
1987	12,293	11.7	10,098	9.3	37,703	8.1	60,094	9.0
1988	13,696	11.4	11,063	9.6	40,743	8.1	65,502	9.0
1989	15,185	10.9	12,080	9.2	44,133	8.3	71,398	9.0
1990	16,790	10.6	13,357	10.6	47,676	8.0	77,823	9.0
1991	18,513	10.3	14,602	9.3	51,712	8.5	84,827	9.0
1992	20,346	9.9	15,843	8.5	55,848	8.0	92,037	8.5
1993	22,299	9.6	17,222	8.7	60,339	8.0	99,860	8.5
1994	24,417	9.5	18,737	8.8	65,195	8.0	108,349	8.5
1995	26,737	9.5	20,405	8.9	70,416	8.0	117,558	8.5
1996	29,250	9.4	22,241	9.0	76,060	8.0	127,551	8.5

ANNEX 14
Table 3

KOREA

SECOND POWER PROJECT

Forecast of Electricity Demand: Low Case

Year	Residential		Commercial		Industrial		Total	
	GWh	%	GWh	%	GWh	%	GWh	%
1984 (actual)	8,757	13.1	7,472	13.9	30,823	8.9	47,051	10.4
1985	9,809	12.0	8,350	11.8	32,421	5.2	50,580	7.5
1986	10,855	10.7	9,223	10.5	34,043	5.0	54,121	7.0
1987	12,035	10.9	10,068	9.2	35,806	5.2	57,909	7.0
1988	13,307	10.6	11,010	9.4	37,646	5.1	61,963	7.0
1989	14,639	10.0	11,997	9.0	39,664	5.4	66,300	7.0
1990	16,058	9.7	13,233	10.3	41,650	5.0	70,941	7.0
1991	17,563	9.4	14,426	9.0	43,918	5.4	75,907	7.0
1992	19,091	8.7	15,494	7.4	46,256	5.3	80,841	6.5
1993	20,637	8.1	16,656	7.5	48,803	5.5	86,096	6.5
1994	22,268	7.9	17,921	7.6	51,503	5.5	91,692	6.5
1995	24,005	7.8	19,283	7.6	54,364	5.6	97,652	6.5
1996	25,853	7.7	20,768	7.7	57,378	5.5	103,999	6.5

KOREA

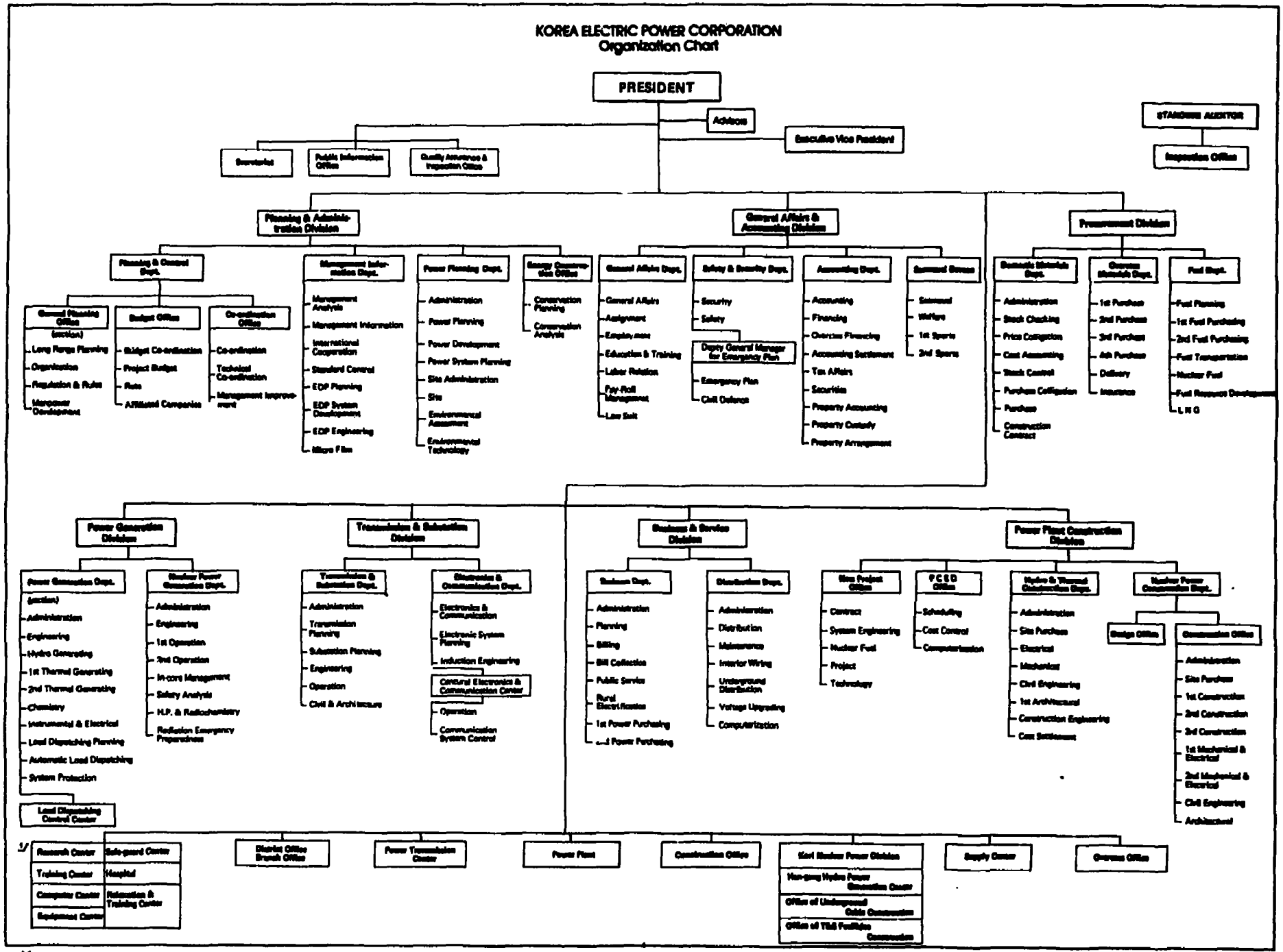
SECOND POWER PROJECT

Selected Documents and Data Available in the Project File

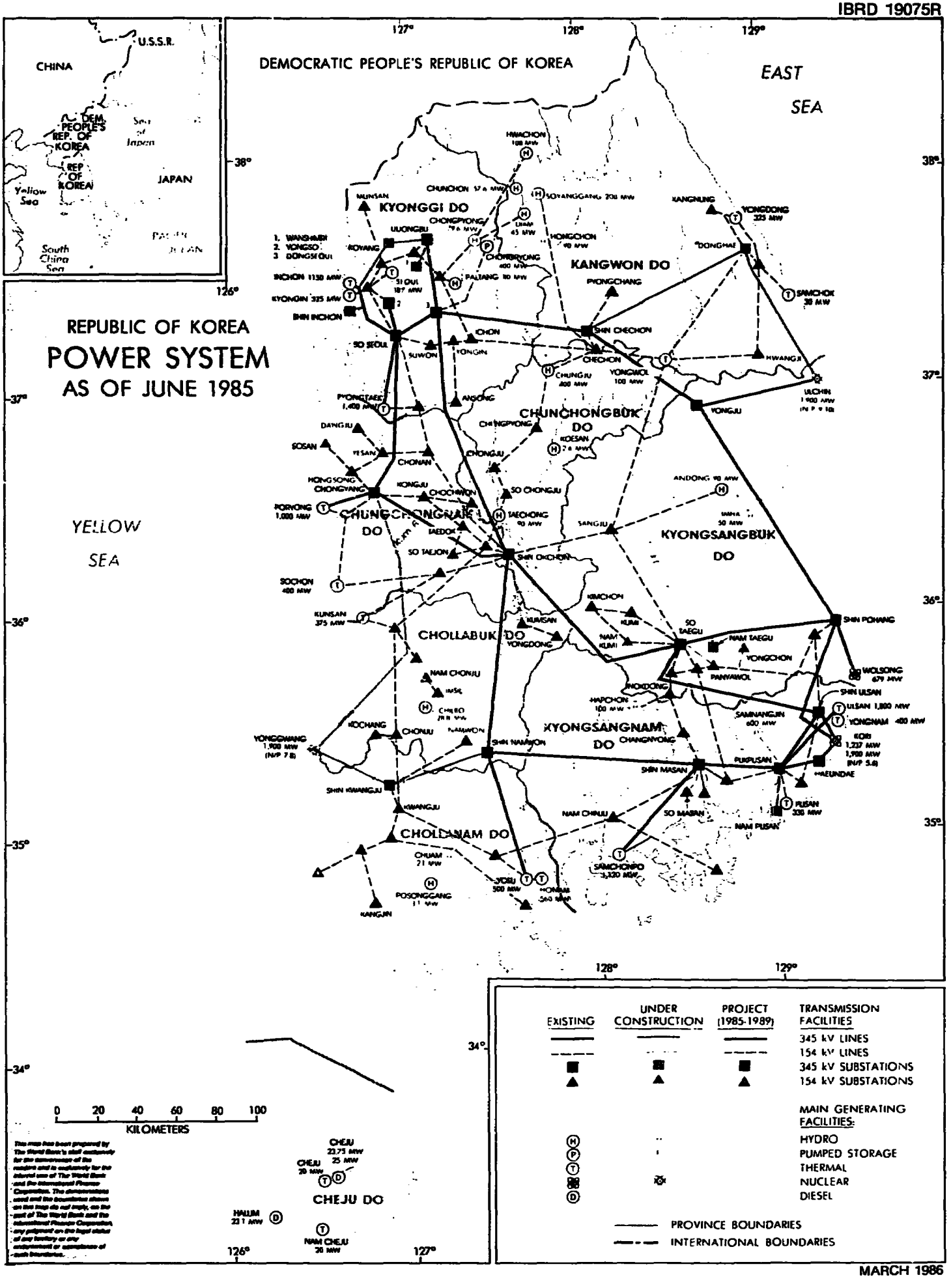
1.	IBRD Report, "Republic of Korea - Energy Sector Issues"	January 1985 307-KO
2.	KEPCO, "A Study on the Improvement of the Electricty Tariff Structure for IBRD Structural Adjustment Loan"	March 1984
3.	KEPCO, "Statistics of Electric Power in Korea,"	1984
4.	KEPCO, "Load Curve Research,"	December 1984
5.	KEPCO, "Rate Regulations for Electric Service,"	April 1983
6.	KEPCO, "Rate Schedules for Electric Service,"	April 1983
7.	KEPCO, "Korea Power Industry in Korea,"	April 1984
8.	EPB, "Introduction to the Government - Invested Enterprise Management Act,"	December 1984
9.	MER, "Yearbook of Energy Statistics,"	1984
10.	East-West Center, "The Electric Future of Korea," Research Material RM-83-8	September 1983
11.	Jang, Y.S., "Need for Loan Research and Load Management by KEPCO," Report prepared under UNDP Project ROK/82/002	September 1984
12.	Description of KEPCO's Transmission System Expansion Process	1983
13.	Description of Loan Management Objectives, Plans and Training Requirements	July 1985
14.	Description of KEPCO's Load Forecasting Methodology	July 1985
15.	Working Papers on Least Cost Generator Expansion Plan for Base High and Low Demand Scenarios	
16.	Working Papers on Rate of Return Calculation	

17.	Details of Transmission/Distribution Costs	
18.	KEPCO, "Long Term Management Plan"	October 1984
19.	KEPCO, "1985 Management Evaluation Manual"	1985
20.	KEPCO, "General Information for Prequalification"	1985
21.	KEPCO, "Articles of Incorporation"	December 1984
22.	KEPCO, "Computer Outputs for Financial Sensitivity Analysis"	July 1985
23.	KEPCO's Implementation Program	July 1985

KOREA ELECTRIC POWER CORPORATION
Organization Chart



1/ Upgraded to "Research and Standardization Division" under a Vice President effective July 1979


U.S.S.R.
CHINA
DEM. PEOPLE'S REP. OF KOREA
REP. OF KOREA
JAPAN
Sea of Japan
Yellow Sea
South China Sea
PACIFIC OCEAN
DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA
EAST SEA
REPUBLIC OF KOREA
POWER SYSTEM
AS OF JUNE 1985
YELLOW SEA
KYONGGI DO
KANGWON DO
CHUNCHONGBUK DO
CHUNGCHONGNAM DO
KYONGSANGBUK DO
CHOLLABUK DO
KYONGSANGNAM DO
CHOLLANAM DO
CHEJU DO
SEOUL
INCHON
SUWON
ICHON
CHUNCHON
CHUNGJU
CHONAN
CHONGJU
TAEJON
TAEGU
PUSAN
KWANGJU
CHONJU
MOKPO
YOSU
ULSAN
POHANG
SHIN KORI
WOLSONG
HWANGJI
YONGJU
ANDONG
SAMCHOK
YONGDONG
PYONGCHANG
SHIN CHECHON
SHIN KWANGJU
SHIN NAMWON
SHIN MASAN
SHIN ULSAN
SAMCHONPO
HALLIM
NAM CHEJU
0 20 40 60 80 100
KILOMETERS
EXISTING
UNDER CONSTRUCTION
PROJECT (1985-1989)
TRANSMISSION FACILITIES
345 kV LINES
154 kV LINES
345 kV SUBSTATIONS
154 kV SUBSTATIONS
MAIN GENERATING FACILITIES:
HYDRO
PUMPED STORAGE
THERMAL
NUCLEAR
DIESEL
PROVINCE BOUNDARIES
INTERNATIONAL BOUNDARIES

MARCH 1986